Welders

Health and Safety Guide

Prepared by the Canadian Centre for Occupational Health and Safety

CCOHS

Emergency Information

_____

Ambulance

_____

Fire

_____

Police

_____

Poison Control Centre

_____

Doctor

_____

Company Emergency Phone Number

Printed by

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Welders Health and Safety Guide

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Prepared with assistance from Gregory J. Naherne, CIH.

Personal Information

This handbook belongs to:

Name _____

Company _____

Position _____

Address _____

Phone _____

Doctor _____

Phone _____

Allergies _____

Medical Conditions _____

_____

_____

_____

In case of emergency please notify:

Name _____

Relation _____

Address _____

_____

Phone _____

Summary

Welding involves a wide range of tasks and hence a wide range of health and safety hazards, which include the following:

- chemical dusts, fumes, vapours and gases
- poor ergonomic working conditions
- electrical hazards
- falls, trips, falling objects
- moving vehicles and cranes
- operating machinery
- arc light radiation, which can expose welders to intense ultraviolet, visible and infrared light
- oxygen displacement, oxygen enrichment or flammable gas mixtures from leaking compressed gas lines and cylinders
- heat, sparks, spatter, open flames and hot surfaces
- noise from metal-on-metal impacts, materials handling, metal working and some welding processes
- confined spaces

This guide outlines the health and safety aspects of welding work, and presents safe welding procedures. For specific guidance applicable to your situation, speak to your supervisor, workplace health and safety representative, health and safety committee member, or to regulatory authorities in your area. Also you may refer to CSA W117.2 standard, "Safety in Welding, Cutting and Allied processes" or ANSI Z49.1 standard, "Safety in Welding, Cutting and Allied Processes"

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Section I

105-04390/

Basic Rules of Safety

1. The Law Says...
2. Elements of On-the-Job Safety
3. Safety Tips for New Employees
4. Safety Tips for Supervisors

1. The Law Says...

The health and safety laws are meant to protect you from workplace injury and illness.

According to the law, it is your employer's responsibility to provide you with a safe and healthy workplace, and your supervisor's responsibility to make sure that you understand the safe way of doing your work.

Working safely is your responsibility. You must use personal protective equipment required by your employer; follow required safety procedures; and report hazardous conditions.

In the occupational health and safety legislation, employees have three important rights:

1. The Right to know potential and actual hazards in the workplace.
2. The Right to participate in health and safety related activities
3. The Right to refuse unsafe work

2. Elements of On-the-Job Safety

1. **The right way is the safe way** of doing your job. Follow instructions. If you don't know, ask.
2. **Know potential hazards** in your work and how to work safely.
3. **Know safety rules for specific jobs** and be able to explain these rules to fellow workers.
4. **Report hazardous conditions** or practices to your supervisor.
5. **Follow emergency procedures** in case of fires, medical incidents and rescues.
6. **Report all injuries** including minor scratches, cuts, burns, slips and falls. Your employer needs this information to take corrective action. Follow your company's procedures for reporting injuries.

7. **Recognize emergency equipment** and know location and proper use of fire extinguishers, eyewash stations and emergency showers.
8. **Use personal protective equipment** as required by your employer.
9. **Learn special safety procedures** for particularly hazardous work such as hot work, confined space entry, electrical work and cutting of containers.
10. **Follow electrical safety rules** when using electrical equipment or portable electrical tools, or when working near overhead power lines.
11. **Understand seasonal safety** procedures for working safely outdoors in cold or hot weather, icy conditions, rain and sunlight (UV rays).
12. **Circle check** any vehicle before using it. Drive safely.
13. **Lock-out** and tag energy sources (electrical, mechanical, hydraulic, pneumatic, chemical, etc.) of all machinery and equipment under repair.
14. **No horseplay.** Horseplay is dangerous and prohibited.
15. **Wear proper clothing for the job**. DO NOT wear loose sleeves, cuffs, rings, bracelets, or anything else that may get caught in moving machinery and cause injury. Long hair, long beards should be secured
16. **Off-the-job safety** is equally important. Safety does not stop when you leave your workplace.

3. Safety Tips for New Employees

When you are starting a new job, ask your supervisor/employer the following health and safety related questions.

- What are the potential hazards of the job?
- Is job safety training available?
- What safety equipment do I need to do my job?
- Will I receive training on how to use the personal protective equipment (PPE) required for the job?

- What should I do in case of fire or another emergency?
- Where do I find fire extinguishers, first aid kits, first aid rooms and emergency assistance?
- What are my responsibilities regarding health and safety?
- If I notice something wrong, to whom should I report?
- Who is responsible for answering safety related questions?
- What should I do if I get injured, or have an accident?
- How can I contact my health and safety committee or representative?

4. Safety Tips for Supervisors

- Inform employees about potential hazards on the job.
- Explain the importance of safety to employees.
- Implement safe work practices.
- Praise safe behaviour.
- Solicit participation and feedback.
- Reward for participation.
- Set an example and follow all rules.
- Promote safety by providing books, videos, literature, etc.
- Visit plant areas regularly.
- Learn the names of employees and build their trust.
- Improve and simplify safety continuously.
- Introduce new employees to the worker health and safety committee member or representative.

Section II

Maintaining a High Standard of Safety

1. Health and Safety Policy
2. Safety Inspections
3. Accident Investigation and Reporting
4. First Aid

1. Health and Safety Policy

Your employer should establish a health and safety programs in consultation with the health and safety committee.

Policy Statement

The policy is a statement of senior management's commitment to health and safety.

The policy statement should state:

- management's commitment to protect the safety and health of employees
- the organization's basic health and safety philosophy
- accountability for occupational health and safety programs
- the general responsibilities of all employees
- that health and safety shall not be sacrificed for expediency
- consequences of inadequate performance of health and safety duties

The policy should be:

- stated in clear, unambiguous and unequivocal terms
- signed by the incumbent Chief Executive Officer
- kept up-to-date
- communicated to each employee
- adhered to in all work activities

Health and safety legislation may require periodic review of the policy. Check the OSH legislation applicable to your workplace. The following is an example of a policy statement.

Occupational Health and Safety Policy

ABC Transport

To all employees *January 1, 1994*

At ABC Transport the safety and health of our employees comes first. Management is committed to doing everything possible to prevent injuries and occupational diseases and to maintain a safe healthy environment.

To this end:

1. All supervisors are responsible to ensure that their employees are trained in occupational diseases and approved safe work procedures, to achieve optimal production without incurring accidents or injuries. Supervisors must ensure that employees work safely and comply with all relevant regulations.
2. All personnel are required to support the OSH program and make safety and health a part of their daily routine and to ensure that they are following safe work methods and relevant regulations.
3. All personnel will be held accountable for implementing this program.
4. All relevant laws and regulations are incorporated in our program as minimum standards.

Bud Hall, President

Source: An OSH Program in Your Work Place. Ottawa: Human Resources Development Canada 1994, with some edits.

2. Safety Inspections

Purpose

Regular workplace inspections are required by law. The purpose of an inspection is to identify unsafe conditions and unsafe practices, and to recommend corrective action.

Inspection Team

Inspection teams may consist of employees, supervisors or managers. When conducting an inspection, team members must use required personal protection to set a good example while ensuring their own safety.

Roles and Responsibilities

Inspections are undertaken in accordance with the legislation. Inspection teams may use a checklist as a guide for conducting inspections. A sample checklist is shown on page 9. You should develop your own list that applies to your workplace.

Inspection Reports

Inspection reports must be communicated to all levels of the organization. Review inspection reports at joint health and safety committee meetings, post them on bulletin boards, and send a copy to management for review. A sample inspection report form is shown on page 10. Inspection reports must be followed up for remedial action, within the timeframe given in your company's health and safety policy and program.

Sample Inspection List

Date _____

Location/Department _____

Yes = Satisfactory No = Unsatisfactory, needs attention

Yes	No	Safe Work Practices
☐	☐	Hot work permits
☐	☐	Use of machine guards
☐	☐	Proper lifting
☐	☐	Designated smoking areas
☐	☐	Welding screens
☐	☐	Proper use of air hoses
☐	☐	No horseplay
☐	☐	Other _____

Yes	No	Use of Personal Protective Equipment
☐	☐	Eye/face protection
☐	☐	Footwear
☐	☐	Gloves
☐	☐	Protective clothing
☐	☐	Head protection
☐	☐	Aprons
☐	☐	Respirators
☐	☐	Fall protection
☐	☐	Other _____

Yes	No	Housekeeping
☐	☐	Proper storage areas
☐	☐	Proper storage of flammable material (oily/greasy rags, etc.)
☐	☐	Other _____

Yes	No	Fire Protection
☐	☐	Fire extinguishers
☐	☐	Proper type/location
☐	☐	Fire equipment maintained
☐	☐	Emergency procedures

Yes	No	Tools and Machinery
☐	☐	Right quality and quantity of required material
☐	☐	Welding torches/gun
☐	☐	Power Tools
☐	☐	Hand Tools
☐	☐	Welding machine/power supply
☐	☐	Operation guards
☐	☐	Gas cylinders
☐	☐	Hoisting rigging
☐	☐	Maintenance, oil leakage
☐	☐	Robots
☐	☐	Other _____

Yes	No	First aid
☐	☐	First aid kits in rooms/ vehicles
☐	☐	Trained first aid providers
☐	☐	Emergency numbers posted
☐	☐	All injuries reported
☐	☐	Other _____

Yes	No	Ventilation
☐	☐	Adequate
☐	☐	Welders' position clear of fumes

Yes	No	Miscellaneous
☐	☐	MSDS*/Labels
☐	☐	Dust/vapour/fume control
☐	☐	Safe use of ladders/scaffolds
☐	☐	New processes or procedures implemented
☐	☐	Other _____

**MSDS= Material Safety Data Sheet for chemicals.*

Notes _____

Sample Inspection Report

Area Inspected _____ Inspector _____ Date _____

Priority Code (See below)	Location	Hazards	Recommended Corrective Action(s)/ Person(s) Responsible	Follow-Up Date	Date Completed
Analysis and Comments					

Priority Code: **A**–do immediately **B**–do within 3 days **C**–do within 2 weeks **D**–other

3. Accident Investigation and Reporting

Purpose

The purpose of accident investigation is to find the cause of the accident and NOT to blame people for it. Accidents as well as incidents (close calls) should be reported and investigated. Workers' Compensation Boards may require additional accident reports on a prescribed form for claims purposes. Ask your employer about these forms.

Most health and safety laws require special reporting procedures for accidents involving serious injuries and specify reporting procedures and timelines. For details, consult the health and safety legislation applicable to your workplace.

Investigation Team

An accident investigation team generally consists of:

- manager/supervisor
- worker health and safety committee representative(s)
- other person as required such as an accident investigation expert (if appointed)

Roles and Responsibilities

You must report any occurrence of an accident or incident to your manager/supervisor immediately. Your manager/supervisor is responsible for conducting the accident investigation and notifying the health and safety committee and other people as required by legislation and by your company.

Report

The accident investigation report is generally submitted as a formal document which includes:

- date and time of report
- name and occupation of the employee
- location, date and time of accident and injury (if any)
- name(s) of witness(es)
- description of the task, including the equipment, working conditions and events leading to the accident
- root cause of the accident
- recommendations for corrective action
- name of the person(s) completing the report

ACCIDENT INVESTIGATION

Investigator's Assessment

What Happened	Root Cause

Witness Interviews

Name	What Happened	Root Cause

Conclusion:

Cause of accident/incident: _____

Probability of recurrence: _____

Recommendations to Prevent Recurrence

Action	Responsibility	Finish Date

Investigated by: _____ Date: _____

Follow-up by: _____ Date: _____

Recommended actions completed by: _____

Example of Accident Report Form

Location

Date _____ Time _____

Reported by _____

Department _____

Location of the accident _____

Injuries

Names of persons affected _____

Nature of injury _____

_____

Possible cause of injury _____

_____

Equipment, tool, substance being used prior to accident

_____

_____

Property, equipment damage

Damaged items _____

Type of damage _____

How did the damage occur _____

Work being done when accident occurred

Description of work _____

Names of persons involved _____

Equipment and tools used _____

Employee(s) trained in proper work procedures _____

SKETCH

4. First Aid

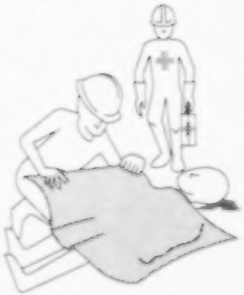
First aid regulations require that employers in all workplaces provide first aid facilities, equipment, and trained personnel with valid first aid certificates. The contents of first aid boxes must be regularly checked and maintained. For information regarding first aid kits refer to legislation in your jurisdiction. For training, contact the local branch of the St. John Ambulance Association, the Canadian Red Cross Society or any other approved organization.

In case of injury:

1. Promptly obtain first aid.
2. Notify your supervisor/employer.
3. Ask your supervisor for a treatment memorandum to take to a doctor or hospital.
4. Complete and promptly return all forms received from the Workers' Compensation Board.
5. Your supervisor should initiate an accident investigation.

Your employer should post the names and workplace telephone numbers of the people who have agreed to provide first aid at the workplace.

Do not move an injured person.



Wait for a qualified person to administer first aid.

Welding Hazards and Controls

1. **Welding and Cutting Processes**
   - Shielded Metal Arc Welding (SMAW)
   - Gas Tungsten Arc Welding (GTAW)
   - Flux Cored Arc Welding (FCAW)
   - Gas Metal Arc Welding (GMAW)
   - Plasma Arc Welding (PAW)
   - Arc Cutting (PAC) and Gouging
   - Submerged Arc Welding (SAW)
   - Resistance Welding (RW)
   - Air Carbon Arc Cutting and Gouging
   - Oxyfuel Welding, Cutting and Heating
2. **Summary of Welding Hazards**
3. **Safe Welding Procedures**
   - Ergonomic Aspects of Welding
   - Electricity
   - Radiation
   - Fumes and Gases
   - Heat and Fire
   - Noise
   - General Safety Hazards
   - Robots

1. Welding and Cutting Processes

Welding is a joining process in which metals, or sometimes plastics, are heated, melted and mixed to produce a joint with properties similar to those of the materials being joined.

Metals can also be cut or separated by a flame or an electric arc, or removed by "gouging" with an electric arc.

Brazing is the joining of metals with a filler metal having a melting point above 450°C (842°F), but below the melting point of base metals.

Soldering is the joining of metals using a filler metal with a melting point below 450°C (842°F).

The heat in welding may come from a flame, an electric arc, friction or pressure. There are over 70 different welding processes, the most common of which are described below. The table on page 25 summarizes hazards associated with different welding processes.

Shielded Metal Arc Welding (SMAW)

This process is often called "stick" or "manual metal arc (MMA)" welding.

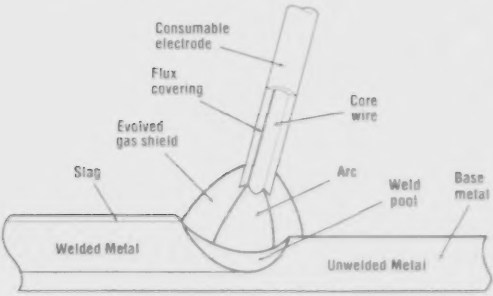


Diagram of SMAW process

In SMAW, an electric arc is produced between the tip of an electrode and the metal being welded. The electrode has a metal core which is covered with a coating or flux. The electrode is used up as it is deposited onto the metal workpiece. This is called a "consumable electrode" process.

The flux ensures arc stability and shields metal ions in the arc from the atmosphere with gases produced as the flux decomposes. The flux also produces a slag blanket to protect the hot weld metal from the atmosphere while it cools.

The electrodes can range in length from 15 to 45 cm (6-18 inches) or more and 0.2 to 1 cm (0.08-0.4 inches) or more in diameter.

SMAW is widely used in construction, structural and repair applications on mild and stainless steels, aluminum and non-ferrous metals. Since the welder must stop welding and replace the electrode each time it has been consumed, SMAW is being displaced today by continuous wire processes. SMAW is widely used in repair and maintenance work.

Gas Tungsten Arc Welding (GTAW)

Gas tungsten arc welding (GTAW) is sometimes called tungsten inert gas (TIG) welding. An early trade name still used for this process is "Heliarc".

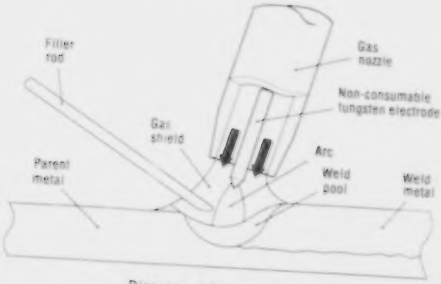


Diagram of GTAW process

In GTAW, an electric arc is established between the tip of a thoriated tungsten electrode and the workpiece. The electrode is not used up, which is why this process is referred to as a "non-consumable electrode" process.

The arc is protected by the flow of a "shielding gas" such as argon, helium or mixtures of these gases which displace atmospheric gases from the weld zone.

The arc in GTAW is very hot and can be used to fuse two metals together without the use of a filler metal. A hand-held "filler rod" can be placed near the heat zone of the arc and melted to fill any gaps.

Because the electrode is not consumed and the filler rod does not transmit current, very little fume and no slag are formed with GTAW.

Ultraviolet (UV) light from the electric arc is very intense and can produce ozone gas due to the action of UV on atmospheric oxygen.

The GTAW process is very clean and is used in critical welding applications such as nuclear reactors, pipeline, and aviation. GTAW is used on mild and stainless steels, aluminum and non-ferrous alloys. It is a relatively quiet process.

The thoriated tungsten electrodes contain 2% to 4% thorium oxide which emits alpha radiation. To avoid inhalation of thorium oxide dust, grind or sharpen electrodes in ventilated or enclosed grinders only. A radiation hazard occurs when thorium oxide enters the body by inhalation, ingestion or skin contamination.

Flux Cored Arc Welding (FCAW)

The flux cored arc welding (FCAW) process is often called "flux cored" for short.

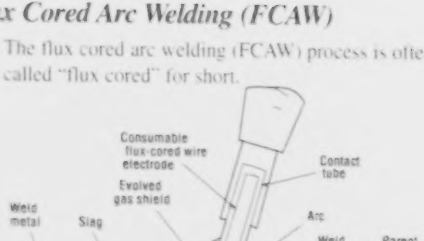


Diagram of FCAW process

In FCAW, a continuous length of wire is fed through a hand-held welding gun from a spool on a wire feeder. The electric arc is established between the tip of the wire and the workpiece. The metal is deposited on the substrate as the wire is consumed.

The wire consists of a metal sheath filled with a flux. The flux helps to establish the arc; decomposes to produce a shield gas; provides additives to the weld metal; and produces a slag covering to protect the hot weld metal.

In "self-shielded" FCAW, the flux decomposes to produce a shielding gas and slag.

In "gas shielded" FCAW, a shielding gas of carbon dioxide or a mixture of carbon dioxide and inert gas (e.g. argon) is used to protect the arc.

The electrodes are between 0.5-2 mm (0.02-0.08 inches).

FCAW is used to weld mild and alloy steels. It is used to weld together thick sections and in the fabrication of ships, railcars and agricultural implements. It can deposit large amounts of metal and can be used to weld poorly fitted or dirty joints. Because of its continuous wire and high productivity, FCAW has replaced SMAW in many fabricating situations. Unfortunately, it can generate large amounts of fume.

Gas Metal Arc Welding (GMAW)

The Gas Metal Arc Welding (GMAW) process is sometimes called "hard wire" or MIG (for metal inert gas).

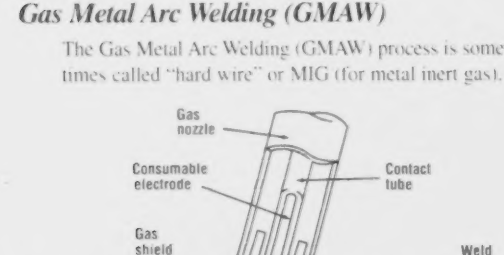


Diagram of GMAW process

In GMAW, a continuous solid wire is supplied through a hand-held welding gun from the spool of a wire feeder. Shielding is provided by an inert gas such as argon, helium, or a mixture of these with carbon

dioxide. Less fume than SMAW or FCAW and no slag are produced, because no flux is used in GMAW.

GMAW is used throughout industry and is now the predominant welding process because of its high productivity and clean welds.

Plasma Arc Welding (PAW) Plasma Arc Cutting (PAC) and Gouging

The plasma processes are similar to the GTAW process. They use a non-consumable tungsten electrode and a shielding gas. In addition, the plasma torch uses a constriction cup which forces the arc out in a narrow jet which has a higher temperature than in GTAW. The use of a constriction cup with a yet smaller diameter orifice produces a finer arc jet which can be used for cutting and gouging applications.

PAW is used for electronic applications.

PAC can be performed under a water surface on a "water table" which traps fumes, gases, arc light and noise. PAC produces a much finer cut which removes less material than oxyfuel cutting and results in much less fume.

During the PAC and PAW processes, the arc jet released into the air through a small orifice produces oxides of nitrogen, ozone and a high frequency noise. Noise levels can be as high as 95 to 100 decibels and pose risk of hearing loss.

Submerged Arc Welding (SAW)

In this process the arc is buried under a bed of granular flux. The flux traps light, fumes, gases and noise.

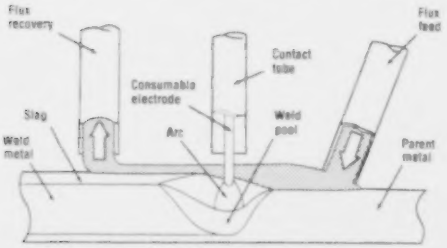


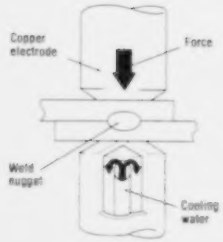
Diagram of SAW process

Bags of flux can weigh up to 40 kg (88 lbs) and can be awkward to handle. Flux must be present, otherwise light, fumes and gases will be released to the environment. SAW uses continuous wire feed.

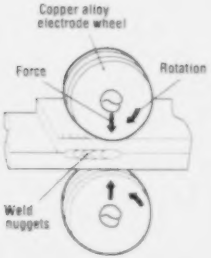
The SAW process is used in the fabrication of line pipe, ship building, and heavy structures.

Resistance Welding (RW)

Resistance welding (RW) is also referred to as "spot welding." Heat from the electric current and pressure applied at the electrode contact points produce a weld. The electrodes are usually copper or copper-beryllium alloy. Copper-berrylium alloy electrodes must be dressed or ground in a locally ventilated equipment. Resistance welding is often used in the fabrication of sheet metal products, tubes, and automobile bodies.



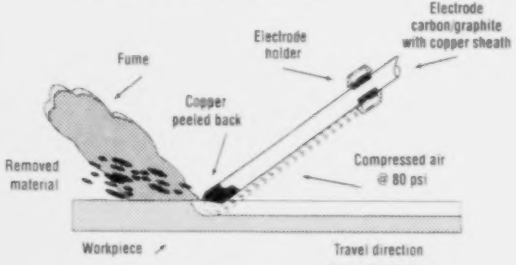
Spot welding



Seam Welding

Air Carbon Arc Cutting and Gouging

In air carbon arc cutting and gouging, a copper coated graphite electrode is used. The electric arc and jet of compressed air causes combustion of the metal which burns off, leaving a gap or hole.



Air-Carbon Arc Cutting

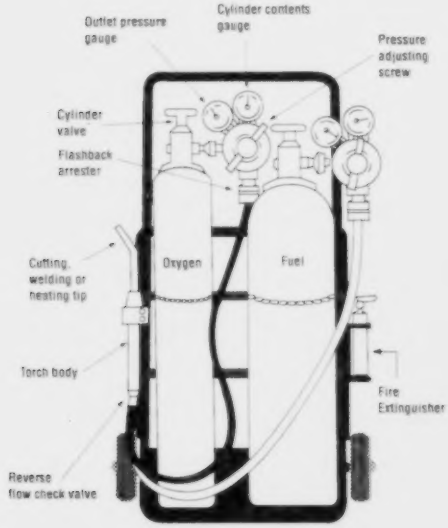
Electrode consumption and metal combustion produce large amounts of fume and gas.

The release of compressed air creates extremely high noise levels which can approach 115 dBA.

Oxyfuel Welding, Cutting and Heating

Compressed oxygen gas and a fuel gas (such as acetylene, propane, or natural gas) are burned together to produce intense heat. The temperature of an oxyfuel flame is about 2,100 to 2,400°C (3812 – 4352°F) depending on the fuel.

The oxy-fuel process was used widely in the past but is used less today. It is still used for brazing and soldering, and for cutting and heating purposes. Cutting is not accomplished by heat alone but with an oxygen-enriched flame which accelerates the burning or combustion of the metal being cut. Heating dislodges seized parts and "preheats" metal surfaces to facilitate welding using other techniques.



Oxyfuel apparatus

2. Summary of Welding Hazards

The types of hazards depend on the welding process and on the environment in which welding is being performed. The controls required for a given hazard depend on the specific situation.

The table below summarizes common hazards in welding processes. These hazards will be described in the following pages.

HAZARD	WELDING PROCESS			
	PAW/PAC Air Carbon Arc Processes	SMAW GTAW GMAW FCAW	SAW	Oxyfuel
Ergonomic	✓	✓	✓	✓
Electric Shock	✓	✓	✓	✗
Bright light	✓	✓	(✓)	✓
Ultraviolet radiation	✓	✓	(✓)	✗
Toxic fumes and gases	✓	✓	(✓)	✓
Heat, fire and burns	✓	✓	✓	✓
Noise	✓	✗	✗	✗

✗ indicates no hazards. ✓ indicates hazard present. (✓) indicates hazard present if SAW flux is absent.

3. Safe Welding Procedures

Ergonomic Aspects of Welding

Background

As much as thirty percent of lost time injuries among welders are due to ergonomically poor job and work-place design. These conditions result in injuries of the back, shoulders, neck, elbows and wrists. Many of these injuries are painful and long-lasting.

Activities which can cause strains and sprains such as back injuries and repetitive strain injuries (RSI) such injuries are also known as work related musculo skeletal disorders, (WMSD). The causes of these injuries include:

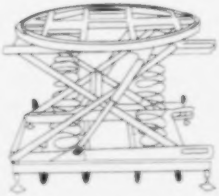
- moving or lifting heavy objects
- working in awkward positions for long periods of time
- repetitive motions

The following can be helpful in avoiding injuries:

- tools with a weight counter-balancer
- better designed work tools and workstations
- elimination of awkward welding postures
- positioning aids
- lift assessment and training
- lifting aids
- improved housekeeping
- job rotation

Working Posture

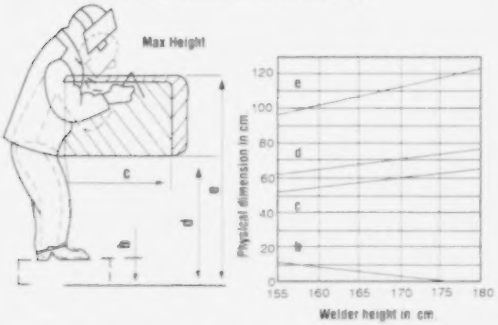
- LEARN to recognize symptoms of RSI. Repeated uncomfortable postures and tasks can cause injury.
- AVOID awkward body positions which cause fatigue, reduce concentration and lead to poor welds which may need to be repeated.
- POSITION yourself in a stable, comfortable posture.
- POSITION the welding item as flat as possible, on a horizontal surface, between waist and elbow height.
- POSITION scaffolding at a comfortable height to allow working in a seated position.
- AVOID working in one position for long periods of time.
- WORK with material slightly below elbow level, while working in a sitting position.
- WORK with material between waist and elbow heights for comfort and precision,when working in a standing position.
- USE a foot rest if standing for long periods.
- ALWAYS store materials and tools within normal reach.
- USE positioning aids to accommodate work posture.



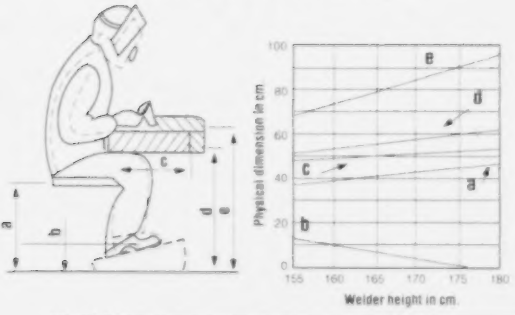
Turntable

Scissor Lift

Standing Workbench Design



Seated Workbench Designs



a = seat height	d = height of the Welding table
b = foot rest height	e = maximum height of the piece being welded
c = maximum reach on the table	

Source: Golavatjuk et.al. creation of optimum labour conditions for electric welders with regard to ergonomic requirements. IIW Calloquium on Welding and Health, Lisboa (1980)

Manual Handling and Lifting

FIND out the weight of an object before attempting to lift it. Do a few warm up stretches before lifting.

USE a lifting aid if the object is heavy.

GET help with heavy or awkward loads if a lifting aid is not available.

PROTECT hands and feet in case the load falls.

Lifting Techniques

Store objects at waist height.

Do not bend over and try to lift the bag all at once.

To Lift from the Ground

1. Raise the object upright.

2. Put one knee against the object.

3. Pull the object up the leg.

4. Rest the object on edge of knee of the other leg.

5. Stand upright.

6. Carry the load as close to the body as possible with your back in upright position.

Lifting Tall Cylinders

USE a trolley or a mechanical lift to lift or move compressed gas cylinders.

PLACE forward foot around the cylinder if it must be lifted manually.

LOWER the cylinder across thigh by pressing down with rear hand while holding cylinder underneath and slightly beyond center point.

RAISE end to desired height.

PUSH cylinder forward by rear hand.

Moving cylinders

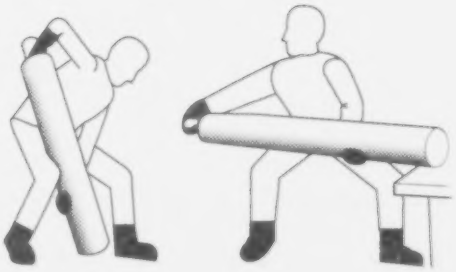
MAKE sure the cylinder cap is secured.

TILT the cylinder slightly on its edge and roll it slowly in the direction desired. Move short distances only.

USE a cylinder trolley for longer distances.

PLACE one hand on top of the cap and the other hand on the shoulder of the cylinder.

ALWAYS chain the cylinder to the trolley.



Lifting cylinders

Lighting

- [x] ENSURE general lighting is adequate to allow safe access and handling of equipment.

USE additional task lighting for precision work.

AVOID excessive glare from light sources or reflections.

PREVENT excessive contrast between the workpiece and background.

Colour

- [x] SELECT matt finishes for welding area to avoid reflection of welding arc light, and to obtain a satisfactory level of lighting.

CHOOSE any colour except blue or turquoise; they reflect UV light.

REDUCE distraction by making piping, ducting or structural supports the same colour as the background, unless piping requires a second colour coding.

Electrical Safety

Electricity used in welding is available as

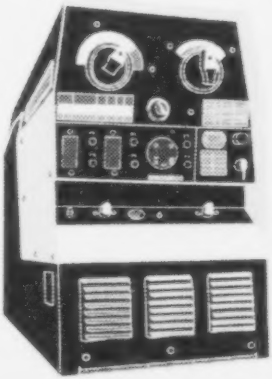
- single phase, 120 Volts (V) or 240 V
- triple phase 575 V in Canada and 480 V in the USA.

☑ Follow electrical safety procedures to prevent electrical hazards.

☒ Never connect an American triple phase power supply directly to a Canadian triple phase voltage input. You will destroy the transformer and possibly injure yourself.

Power Supplies

All power supplies must meet the guidelines set by CSA standard C22.1 Canadian Electrical Code (in Canada) or ANSI C2-1997 National Electrical Safety Code (in the USA), or by your local electrical utility or other appropriate body.



The primary voltage inputs to the power supplies are stepped down by a transformer, to give the lower secondary open circuit voltages of about 80 V DC Direct Current) for manual and semi-automatic equipment and about 100 V for automatic equipment. The voltage drops to about 15 V to 30 V once the arc is established and current is flowing.

Arc welding requires very high currents. Typical DC welding currents are between 150 Amperes (A) and 500 A for manual welding and higher for semi-automated and robotic welding.

Common Electrical Hazards

Electric Shock

The human body conducts electricity. Even low currents may cause severe health effects. Spasms, burns, muscle paralysis, or death can result depending on the amount of the current flowing through the body.

Effects of Electrical Shock

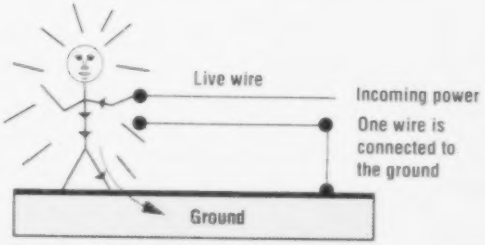
Effect	DC Current (mA)
Death	1000
Ventricular Fibrilation	50+
Paralysis of Diaphragm	30 - 40
Makes hands "Clamp-on"	15 - 20
Involuntary Reflexes	2+
Perception	< 1

Completion of Circuit through the Body

If a person touches a live conductor, current may flow through the body to the ground and cause a shock.

Increased electrical contact with the ground increases the risk of shock.

Avoid standing in water, on wet surfaces, or working with wet hands or wearing sweaty garments.



Completion of an electric circuit through ground

Small shocks could cause you to slip and fall, possibly from a high place.

In Case of Electric Shock

- **Disconnect and turn off** the power first.
- Do not try to pull the victim free with "bare hands".
- Insulate yourself if you must pull a victim from a live contact.
- Give artificial respiration if the victim is not breathing.
- Give CPR if the victim's heart has stopped (but only if you're trained in CPR).
- Call for medical help.
- Keep the victim comfortable and at rest, and monitor breathing.

Electrical Installation

READ the manufacturer's operating instructions before using equipment for the first time.

ENSURE all electrical installation is done by a qualified electrician.

ENSURE that the welding equipment has the required current capacity and is properly grounded.

COVER the lug terminals to prevent short out

ENSURE that properly sized fuses or circuit breakers are in place for overload protection.

KEEP the primary voltage cable as short as possible and protected at all times.

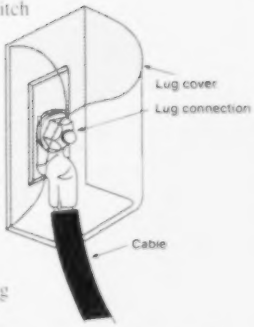
TURN the disconnect switch off before plugging or unplugging the high voltage input cable.

HAVE welding equipment correctly connected before use.

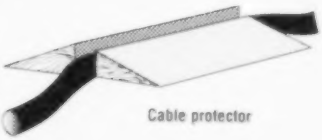
STAND to the side when turning "on" the disconnect switch.

LOCATE main power terminals inside welding machine cover. Ensure terminals are accessible only with tools.

USE cable protectors to prevent crushing of cable by passing vehicles or trolleys.



Electrical Connection into the power supply.



Cable protector

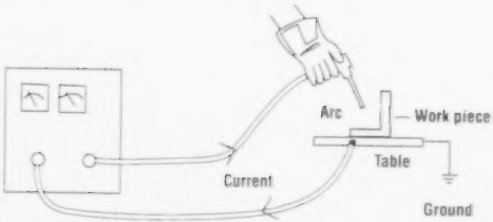
DO NOT lay materials on cables or drive vehicles over them.

DO NOT do electrical installation or repair work if you are not qualified.

Welding Circuit

The welding machine is connected by a cable to the electrode holder. Electric current flows through the cable and the electrode to create an arc which passes the current to the workpiece. The current is then returned to the power supply through the work return lead.

The work return lead is not a true electrical ground lead. It serves only to complete the welding electrical circuit.



Work lead to complete circuit

Connections

- FOLLOW grounding rules recommended by the equipment manufacturer.
- ENSURE welding cable is rated for the current required.
- KEEP electrical connections tight, clean, and dry to prevent heating or sparking of the connections.
- REMOVE any paint, grease, rust or other coatings which could prevent electrical flow and produce toxic airborne contaminants.
- ALWAYS verify the contents before attaching welding return current cable to pipes.
- HAVE the electrical continuity verified by a competent electrician.
- PLACE cables where they are safe from damage.

USE the correct size welding cable and work return lead for the current load.

- cable size depends on the duty cycle which is the proportion of time that the current is actually flowing.
- long cables require a larger diameter (heavier gauge) than short cables.

AVOID cables that are longer than necessary. Use the shortest cable practicable.

PLACE drip loops in cooling hoses to prevent condensation from running into electrical equipment.

REPLACE weld lead spliced within 3 m (10 ft.) of the electrode holder.

DO NOT ground to pipelines carrying gases, flammable liquids or electrical conductors.

DO NOT use any leaking water cooled equipment.

DO NOT wind a cable around your body.

Workpiece Grounding

Ground the workpiece separately, preferably at the workpiece itself but alternately at the welding machine. Ensure that the welding machine is grounded to the electrical panel input into the building. This will prevent the workpiece from becoming "live" in the event of a fault in the welding machine.

Spools

Continuous welding wires are on a spool. Wire which is advanced by a wire feeder and the current is conducted through the electrode.

The wire spool is "live" while the wire is being fed. In some cases, the wire and spool can be "live" without the arc burning or the wire being fed; the operator could be exposed to the full open circuit voltage if contact occurs. Reduce this hazard by installing separate contactors.

Equipment Maintenance and Inspection

INSPECT regularly and keep records.

CHECK oil level and moisture content in oil-cooled transformers.

PREVENT overheating. Measure current with portable ammeters to ensure that load current does not increase beyond the capacity of the equipment.

CLEAN equipment according to manufacturer's recommendations.

ENSURE adequate ventilation and proper operation of cooling fans.

Welding Equipment

CHECK all external connections daily.

CHECK welding leads for damage.

CHECK the electrode holder for:

- loosened screws in the holder
- burned or cracked insulation
- overheated and damaged connections

REPORT defective electrode holders and guns, improper insulation, overheating, or any suspected defects or malfunctions.

ENSURE all connections are tight and contact areas are clean.

SECURE the "welding cable" and "work return lead" to the work, with a bolt for a strip conductor.

USE a cable lug or a clamp for stranded connectors.

ENSURE welding lead and return are sized for maximum welding amperage.

REFUSE to use unsafe equipment until it is repaired or replaced.

Engine Driven Equipment

- [x] LOCATE equipment on a level base protected from weather. Temporary shelter may be required for equipment used outdoors. Block wheels to prevent movement.

ENSURE fuel tank has no leaks.

CONDUCT engine exhaust outside when working indoors.

ENSURE that the welding machine frame is grounded, with special attention to ground connectors.

GROUND according to electrical code and manufacturer's instructions. This usually requires a 2 m long copper rod (about 2 m or 6 ft. long) driven into the ground.

MAKE SURE the plugs and sockets connecting welding machines to power are clean and free of moisture. Install caps on plugs and sockets which are not in use.

CHECK for leaks in gas hoses if GMA or GTA welding.

CONNECT to the transformer or generator with the proper plugs or lugs.

DE-ENERGIZE electric power when connecting the cables.

USE proper cable couplings to extend leads.

STAND well away from plug and socket when power is turned on.

Electric Welding Equipment

STORE electrode holders where they cannot contact workers, fuels or compressed gas leaks.

REMOVE all electrodes from holders and disconnect the machine from power source when welding is stopped for any period of time.

RETRACT or cut off wire electrodes in semi-automatic holders to prevent contact.

KEEP electrode holders and electrodes dry. When exposed to water or steam, dry thoroughly before further use.

DEPOSIT electrode stubs in a container to prevent welders from slipping or falling on them.

DO NOT change electrodes with bare hands or wet gloves, or when standing on wet floors or grounded surfaces.

DO NOT cool electrode holders by dipping them in water.

DO NOT switch the polarity switch of an electric welder in operation. Turn off equipment to change polarity.

DO NOT burn electrodes to less than 38 to 50 mm (1.5 to 2 in.) in length. Burning them shorter damages the electrode holder insulators, and may result in an accidental short circuit.

Magnetic Fields

Some researchers have found that exposure to power frequency magnetic fields may increase the risk of certain forms of cancer. Although these results are inconclusive, avoiding unnecessary exposure is recommended.

Arc welding units use very high electric currents. As a result, they are also sources of magnetic fields. The strength of magnetic fields increases as the electric current increases.

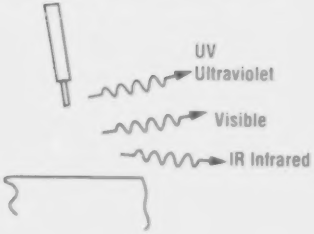
Very large fluctuating magnetic fields may emanate from welding cables. Lay cables in straight lines and isolate them from each other to reduce the intensity of the magnetic fields. The intensity of magnetic fields decreases considerably as the distance from the cable increases.

Strong magnetic fields may affect pacemakers. Anyone wearing a pacemaker should consult his/her doctor before working near such strong current equipment.

Radiation

Types of Radiation Produced in Welding and Cutting

Welding arcs and flames emit intense visible (VIS) light, ultraviolet (UV) radiation, and infrared (IR) radiation.



Radiation Emitted by Arc

Hazards of Welding Radiation

Skin and eye damage are the main risks of light from welding processes.

Effects on the Skin

UV radiation in a welding arc will tan and burn the skin just like UV radiation in sunlight. Long-term exposure to UV radiation can cause skin cancer.

Infrared radiation and visible light normally have very little effect on the skin.

UV-radiation is divided into three subcatagories – UV-A, UV-B and UV-C. UV-C and almost all UV-B are absorbed in the cornea of the eye. UV-A passes through cornea and is absorbed in the lens of the eye.

Effects On the Eye

Certain types of UV radiation can produce an injury to the surface and mucous membrane of the eye called "arc eye," "welders' eye" or "arc flash." Exposure to just a few seconds of intense UV light can cause arc eye.

Symptoms of Arc Eye

- pain, ranging from a mild feeling of pressure in the eyes to intense pain in severe instances
- tearing and reddening of the eye and membranes around the eye
- sensation of "sand in the eye" or abnormal sensitivity to light
- inability to look at light sources (photophobia)

These symptoms may not be felt until several hours after exposure.

Long-term exposure to UV light can produce cataracts in some persons.

Visible light from welding processes is very bright and can overwhelm the ability of the iris of the eye to close sufficiently and rapidly enough to limit the brightness of the light reaching the retina. The result is that the light is temporarily blinding and fatiguing to the eye.

A serious concern is the "blue light hazard" which is the temporary or permanent scarring of the retina due to its sensitivity to blue light, around 440 nm wavelength. Blindness may result.

Exposure to infrared light can heat the lens of the eye and produce cataracts over the long term.

Protection from Welding Radiation

Skin Protection

- [x] WEAR tightly woven work-weight fabrics to keep UV from reaching the skin.

BUTTON up the shirt to protect the skin on the throat and neck.

WEAR long sleeves and pant legs.

COVER the head with a fabric cap to protect the scalp from UV.

PROTECT the back of the head by using a hood.

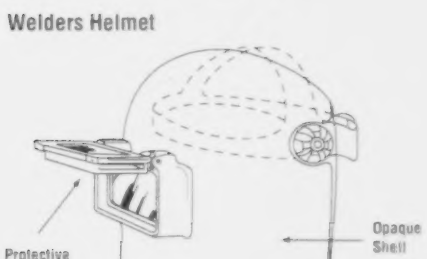
PROTECT the face from UV by wearing a tight-fitting, opaque welder's helmet.

MAKE SURE that all fabric garments are resistant to spark, heat and flame. Keep the fabrics clean and free of combustible materials that could be ignited by a spark.

Eye Protection

The eyes are protected from welding light by a filter shade mounted on the welder's helmet.

Welders Helmet



Eye protection assembly

The helmet shell must be opaque to light and resistant to impact, heat and electricity. It is supported on the head with a headband and cradle assembly. The shell is hinged so that it can be lowered during welding and raised after.

Eye protection is provided in an assembly which includes the following components:

Outer cover plate made of polycarbonate plastic which protects from UV, impact and scratches.

Filter lens made of glass containing a filler which reduces the amount of light passing through to the eyes. The filler is fragile and sensitive to impact and sudden heat changes. Filters are available in different shade numbers ranging from 2 to 14. The higher the number, the darker the filter and the less light passes through the lens. Gold plated plastic filter lenses are available. The coating on these must be protected from scratches and burns.

Clear retainer lens made of plastic prevents any broken pieces of the filter lens from reaching the eye.

Gasket made of heat insulating material between the cover lens and the filter lens protects the lens from sudden heat changes which could cause it to break. In some models the heat insulation is provided by the frame mount instead of a separate gasket.

Some Good Practices with Welding Helmets

- CHOOSE a tight fitting helmet to help reduce light reflection into the helmet through the space between the shell and the head.
- WEAR the helmet correctly. Don't use it as a hand shield.
- PROTECT the shade lens from impact and temperature changes that could cause it to crack.
- USE a cover lens to protect the filter shade lens. Replace the cover lens if it gets scratched or hazy.
- MAKE sure to replace the gasket if your helmet uses one.
- REPLACE the clear retaining lens to protect your eyes from broken pieces.
- CLEAN lenses periodically.
- DISCARD dirty or damaged lenses.

Filter Shade Selection for Arc Welding

The correct filter shade is selected according to the welding process, wire diameter, and operating current. The table below gives the correct shade numbers for different situations.

☑ ALWAYS use suggested shade numbers instead of minimum shades.

Shade Numbers for Arc Processes (from CSA W117.2)

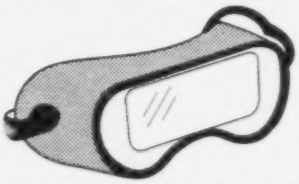
Process	Electrode Diameter (mm)	Current (Amperes)	Minimum Shade	Suggested Shade
SMAW	< 2.5	< 60	7	-
	2.5 - 4	60 - 160	8	10
	4 - 6.4	160 -250	10	12
	> 6.4	250 - 550	11	14
GMAW and FCAW		< 60	7	-
		60 -160	10	11
		160 -250	10	12
		250 -500	10	14
Air Carbon Arc Cutting				
light		< 500	10	12
heavy		500 -1000	11	14

**In the United States use ANSI/AWS Standard F2.2 for selecting filter lens shades.*

PROVIDE supplementary task lighting that suits welders' visual acuity.

USE the same shade as the welder's if you are directly observing the arc.

For gas cutting, welding and brazing, the intensity of the light is much less than from arc welding. Lighter shade filter lenses are used with goggles in place of a helmet.

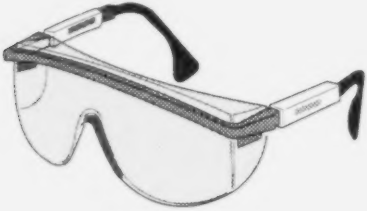


The correct shade numbers for oxyfuel cutting are shown in the table below.

Shade Numbers for Cutting (from CSA W117.2)

Process	Plate Thickness (in mm)	Minimum Shade #	Suggested Shade #
Light	< 25	3	4
Medium	25 - 150	4	5
Heavy	> 150	5	6

** In the US use ANSI/AWS Standard F2.2 for selecting filter lens shade.*



Protecting the Eyes from Flying Particles

Eye injury can occur from hot slag that can fly off from the weld during cooling, chipping or grinding.

☑ ALWAYS wear safety glasses with side shields under the welding helmet or goggle.

What About Contact Lenses?

Dust particles or chemicals that can irritate the eyes may be present in many welding areas. Wearing contact lenses may not be advisable in such workplaces.

Reports of contact lenses being "welded" to the cornea (or lens) of the eye as the result of an arc flash have been proven to be incorrect. It is impossible for contact lenses to become welded to the cornea.

Protecting Helpers and Adjacent Workers

Persons near a welding operation can suffer an arc flash by inadvertently looking directly at an arc struck or being exposed to reflected light.

☑ SHIELD welding activities in a welding booth or by fire resistant, non-reflective screens and partitions or curtains, to minimize the risk of exposing other workers to arc light.

USE spark or spatter shields to prevent the escape of hot material from the welding area into adjacent locations.

WEAR proper eye protection if you are within 30 m (100 ft) of an unshielded welding area.

USE polycarbonate plastic lenses to absorb most of the UV light. Tinting helps reduce the visible and infrared light.

WEAR tinted polycarbonate safety glasses with tinted side shields if you are helping or working near a welder. Use a #3 or #5 shade if you are not looking directly at the arc. If you must look directly at the arc, use the same shade as the welder.

WEAR slightly tinted (#2 shade) polycarbonate safety glasses with tinted side shields for protection from incidental reflected light. If you must look directly at the arc, use the same shade as the welder.

DO NOT obstruct ventilation. Ensure that the fume removal system is working.

Ionizing Radiation

Ionizing radiation is emitted by radioactive materials and x-ray machines. Exposure to ionizing radiation increases the risk of cancer in exposed persons, and genetic abnormalities in children and grandchildren of exposed persons.

Electron beam welding is the only process that can produce x-ray (ionizing radiation); it is not commonly used.

Welds are sometimes checked by non-destructive testing to detect faults. These testing methods use ionizing radiation and, therefore, are also known as radiography.

Ionizing radiation may be a welding concern if thoriated tungsten electrodes are used.

ALLOW only trained, authorized persons to perform radiographic testing.

FOLLOW radiation protection rules to minimize exposure.

ESTABLISH rigorous safety procedures and a restricted area around ionizing radiation sources.

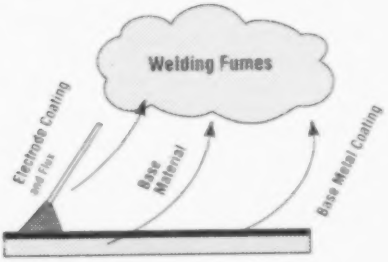
INDICATE the presence of ionizing radiation in the area by posting signs that have the ionizing radiation warning symbol.

ENSURE that all workers are trained/educated about the significance/importance of these signs.

Ionizing radiation is commonly used in various types of industrial gauges to measure flow, density or thickness. Maintenance welders must know:

- where these gauges are present in the workplace,
- how to isolate these in order to work safely in their vicinity, and
- what to do in case of accidental exposure.

Fumes and Gases



Fumes

Fumes are formed when a metal is heated above its boiling point and its vapours condense into very fine solid particulates.

In a process where the electrode is being used up (e.g. a consumable electrode process), the fumes come mostly from the electrode, electrode coating or fluxes. Only a small part comes from the metal being welded.

When a coated surface is being welded, large amounts of fume may be generated from the coating.

In a non-consumable electrode process, the amount of fume is smaller and comes from the metal and the filler rod.

Gases

Gases are produced by the decomposition of fluxes and shielding gases or from the interaction of ultraviolet light or high temperatures with atmospheric gases.

Welding Fumes

Fume Composition

Welding fumes are a complex mixture of metallic oxides, silicates and fluorides. Fluxes containing silica or fluoride produce amorphous silica, metallic silicates and fluoride fumes.

Fumes from mild steel welding contains mostly iron with small amounts of additive metals (chromium, nickel, manganese, molybdenum, vanadium, titanium, cobalt, copper etc.).

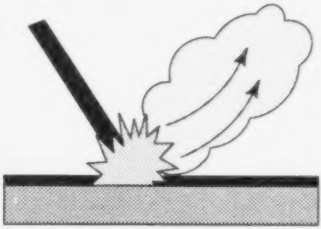
Stainless steels have larger amounts of chromium or nickel in the fume and lesser amounts of iron.

Nickel alloys have much more nickel in the fume and very little iron.

Coatings

Vapours or fumes can come from coatings and residues on metal being welded. Some ingredients in coatings can have toxic effects:

- Metal working fluids, oils and rust inhibitors. Metal working fluids can adversely affect the lungs and skin.
- Zinc on galvanized steel vaporizes to produce zinc oxide fume, which can cause a metal fume fever.
- Cadmium plating can produce a metal fume fever and delayed kidney damage that can be fatal.
- Vapours from paints and solvents cause irritation and toxic effects. Check the MSDS.
- Lead oxide primer paints can greatly overexpose a welder to lead.
- Some plastic coatings can produce "polymer fume fever."



Metal Coatings – A Source of Hazardous Fumes

Removal of Coatings

REMOVE coatings from the weld area to minimize the fume. The removal of coating will also improve weld quality.

USE stripping products to remove coatings. Make sure to remove any residues before welding.

USE wet slurry vacuum removal techniques for removing very toxic coatings.

DO NOT grind coatings. Grinding dust may be toxic.

Health Effects of Welding Fumes

The health effects of fumes range from discomfort to long term illness depending on the amount of exposure and the constituents in the fume. In general, welders tend to have poorer respiratory health than non-welders.

Acute Effects

Some metals in the welding fumes, such as copper, zinc, and cadmium can produce a flu-like condition known as 'metal fume fever'. This acute condition occurs when a freshly formed fume is inhaled. Symptoms of 'metal fume fever' include headache, fever, shivers and a metallic taste in the mouth. The symptoms usually last 24 to 36 hours. Copper and zinc are rapidly excreted from the body and no long-term effects occur.

Long-Term Effects

Long-term health effects of welding fumes depend on the contents of the fumes. For details check material safety data sheets (MSDS) of materials used.

Some substances in welding fumes can accumulate in the body and may cause long-term effects. For example, severe cadmium exposure may cause kidney damage or failure; nickel and cadmium can cause cancer; and lead and manganese affect the nervous system.

Welding fumes have been classified as a possible carcinogen to humans in Group 2B by the International Agency for Research on Cancer (IARC, monograph vol. 49, page 507.) Human studies have failed to show a clear cause-effect relationship between welding fume and lung cancer, but welding fume may contain known human carcinogens. The best precaution is to limit welding fume exposure as much as possible.

Welding Gases

Gases Used in Welding and Cutting Processes

- shielding gases such as carbon dioxide, argon, helium, etc.
- fuel gases such as acetylene, propane, butane, etc.
- oxygen, used with fuel gases and also in small amounts in some shielding gas mixtures

Gases Produced from Welding and Cutting Processes

- carbon dioxide from the decomposition of fluxes
- carbon monoxide from the breakdown of carbon dioxide shielding gas in arc welding
- ozone from the interaction of electric arc with atmospheric oxygen
- nitrogen oxides from the heating of atmospheric oxygen and nitrogen
- hydrogen chloride and phosgene produced by the reaction between ultraviolet light and the vapours from chlorinated hydrocarbon degreasing solvents

Some of these gases irritate and can damage the respiratory system. Many chlorinated hydrocarbons such as commonly used methyl chloroform are ozone-depleting substances and are no longer used for environmental reasons.

Gases are also produced from the thermal breakdown and combustion of coatings.

- Polyurethane coatings can produce hydrogen cyanide, formaldehyde and toluene diisocyanate.
- Epoxy coatings can produce carbon monoxide, carbon dioxide, formaldehyde and phenol.
- Vinyl paints can produce hydrogen chloride.
- Phosphate rust-inhibiting paints can release phosphine during welding processes.

Minimizing exposure to degreasing solvent vapours

USE substitute materials such as water-based cleaners or high flash point solvents.

COVER the degreaser baths or containers.

DO NOT weld on surfaces that are still wet with a degreasing solvent.

DO NOT weld near degreasing baths.

DO NOT use chlorinated hydrocarbon degreasers.

Hazards from Gases

- asphyxiation (lack of oxygen)
- fire or explosion
- toxicity

Asphyxiation

Simple asphyxiants, are non-toxic gases but can displace oxygen and diminish the amount of oxygen available to breathe. Argon, helium, nitrogen, carbon dioxide and fuel gases are simple asphyxiants.

Remember: Diminished oxygen can cause inattention, disorientation, dizziness, unconsciousness, or even death if the oxygen content drops too low. Clean outdoor air contains about 20.9% oxygen by volume. CSA standard Z94.4 M1982 defines oxygen deficiency as oxygen content of less than 19.5% by volume. Consult your health and safety legislation for exact number.

Fire or Explosion

Oxyfuel processes involve the use of fuel gases and oxygen gas.

Fuel gases like acetylene which are lighter than air (vapour density less than 1) tend to rise to the ceiling. Heavy fuel gases (vapour density greater than 1) like propane or butane fall to the ground. Flammable mixtures of fuel gases can ignite and cause a fire.

Fuel gases can also displace oxygen and act as simple asphyxiants.

Oxygen can leak and enrich the atmosphere, making substances more flammable and difficult to extinguish.

Toxicity

Some gases may cause toxic effects check MSDS for details

Safety Tips:

- Have adequate ventilation in a workplace to prevent the displacement or enrichment of oxygen and to prevent the accumulation of flammable atmospheres.
- Do not use a compressed gas to blow off dust.

How Can Exposure to Fumes and Gases Be Controlled?

- Reduce the amount generated at the source.
- Remove the contaminants from the welder's work area through mechanical ventilation.

Control at the Source

Reducing the amount of contaminants generated at the source is preferred. The following are common methods of control.

Process Selection

Some welding processes generate more welding fume than others. The following list ranks fume generation for common processes from the highest to the lowest:

- Flux Core Arc Welding (FCAW)
- Shielded Metal Arc Welding (SMAW)
- Gas Metal Arc Welding (GMAW)
- Pulsed Gas Metal Arc Welding (P-GMAW)
- Gas Tungsten Arc Welding (GTAW)

Lower fume concentration may be offset by high levels of ozone and oxides of nitrogen.

For cutting and gouging, plasma arc processes produce much less fume than oxyfuel or air arc carbon processes, simply because they produce finer cuts and remove less material.

Safety Tip:

Choose the welding process that produces the best possible weld or cut while generating the least amount of fume.

Material Selection

The type of material being welded can affect the fume generation rate. Aluminum evaporates more readily than mild steel, and produces more fume. Similarly, mild steel produces more fume than stainless steel or nickel alloys.

In aluminum welding, the use of magnesium containing alloys in place of silicon aluminum alloys can reduce the amount of ozone produced in GMAW.

Safety Tip:

Choose the material that will give the most suitable weld while producing the least amount of contaminants.

Electrode Selection

Many manufacturers offer "low fume" versions of their electrodes. If a "low fume" electrode meets the requirements for a given "electrode class," then it will produce just as good a weld as any other electrode in its class.

Safety Tips:

- Use "low fume" electrodes which are compatible with your welding application to reduce the amount of fume generated.
- Contact your supplier for "low fume" versions of electrodes for your application.
- Contact other manufacturers for "low fume" electrodes if your existing supplier doesn't have suitable ones for your application.
- Learn about and adapt to any limitations or special requirements of "low fume" electrodes in order to take advantage of their benefits.

Shielding Gas Selection

The shielding gas used can affect the amount of fume generated. For example, in FCAW, mixtures of argon and carbon dioxide produce less fume than carbon dioxide alone. Similar reductions can be obtained for many other welding processes. Some manufacturers have proprietary shielding gas mixtures which offer fume reduction properties. In aluminum welding, helium-containing shielding gases can reduce the amount of ozone produced in GMAW.

Safety Tips:

- Use a shielding gas that is compatible with your application to reduce fume generation.
- Use mixed gases for FCAW to reduce the amount of fume.
- Contact your supplier for shielding gas recommendations.

Welding Parameter Selection

The welding parameters (or settings) can affect how much fume is generated. Some of these include:

Current	The higher the current, the more fume will be produced. An exception is GMAW of aluminum where higher currents generate less fume.
Voltage	Fume generation increases with welding voltage.
Tip-to-work distance	The longer the distance between the tip of the electrode and the work piece, the greater will be the amount of fume. (More vapourized metal is exposed to the environment).
Wire feed speed	Fume generation increases with wire feed speed. (More metal is being used.)
Humidity	Moisture absorbed by fluxes increases the amount of fume produced.
Position	Less fume tends to be produced in a flat horizontal position than in vertical or overhead positions.

Use the chart on the next page to record the welding parameters (operating condition settings) for your work.

Welding parameters

Welding Task Type	Process	Materials	Electrode	Shielding Gas	Welding Parameters		
					Current	Voltage	Wire Feed Speed
Butt Welds	GMAW	Mild Steel	ER70S6	Argon	250	25	150

Other factors include travel speed, deposition rate and electrode angle.

Safety Tip: Do not change welding procedures to finish the job faster by increasing tip to work distance or wire feed speed.

Ventilation

The purpose of ventilation is to remove air contaminants from the welder's breathing zone.

Different ventilation strategies may be needed in each case to control exposure. General guidelines have been published in CSA W117.2 "Safety in Welding, Cutting, and Allied Processes", and ANSI Z49.1 Standard " Safety in Welding and Cutting".

Weld out of the plume and use a tight fitting welding helmet to shield you from the plume.

Keep out of the plume

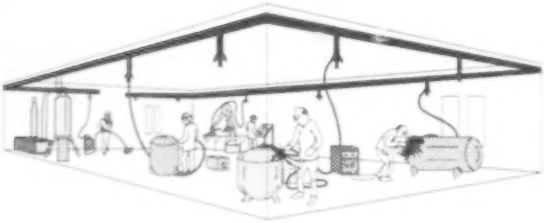
There are two kinds of ventilation:

1. Dilution ventilation dilutes contaminated air in the work area by drawing in outside air and exhausting used (contaminated) air.
2. Local ventilation exhausts or removes the toxic gases, fumes, dusts and vapours before they can mix with the room air.

Local exhaust ventilation is always the preferred method of removing welding fumes and gases.

Local Exhaust for Welding Stations

Local exhaust ventilation captures contaminants at the source and keeps them from dispersing into the workplace environment. It draws less air and can be less expensive to operate.



Welding Bench

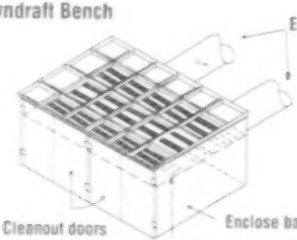
A welding bench has a slotted rear hood through which contaminants are drawn away from the breathing zone. End baffles are useful for keeping away side drafts. The maximum depth of the bench should be 60 cm (24 in.). A welding bench is useful for production or repair welding of small pieces. If large objects are welded, they may be too heavy to place safely on the bench.

Safety Tips:

- Slots must be sized for at least 2000 feet per min. (ft/min)or 10 metres per second (m/s) of air velocity.
- Locate the workpiece to have an airflow of at least 0.5 m/s (100 ft/min) at the welding arc.
- Place workpiece so that contaminants are drawn away from your face.
- For large pieces use a turntable, to allow access to all sides of the object.

Source: ACGIH Industrial Ventilation – A Manual of Recommended Practice.

Downdraft Bench



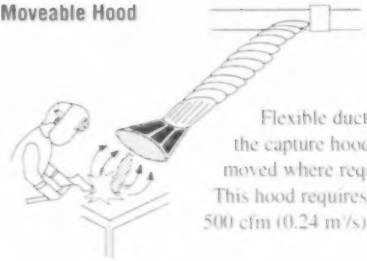
A downdraft bench is an open grid work surface on which the workpiece rests.

- Air is drawn downward through the grid, drawing contaminants into exhaust ducting.
- Very good for oxyfuel and plasma processes where contaminants are being projected down into the capture slots.
- Also useful for welding of materials which emit fume from the back side, such as galvanized steels.

Safety Tips:

- Air speed must be great enough to keep contaminants from rising into your breathing zone.
- If workpieces are too large they may block the ventilation airflow or cause pockets of high velocity air (could affect shielding gases).

Moveable Hood

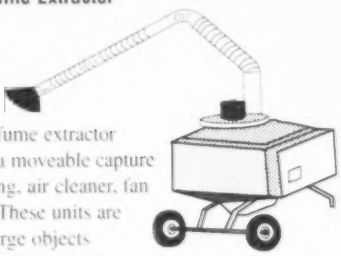


Flexible ducting allows the capture hood to be moved where required. This hood requires about 500 cfm (0.24 m³/s)

Safety Tips:

- Provide an air velocity of at least 100 ft/min (0.5m/s) across the welding arc.
- Avoid an air velocity above 150 ft/min (0.75 m/s) because it can strip away shielding gas.
- Place the hood as close as practical to the work. The optimal location for the hood is about 1 duct diameter from the arc.
- Use flanged or conical hoods as they are more efficient than plain duct ends.
- Repair any tears or holes in the duct or capture hood to maintain efficiency.

Portable Fume Extractor



A portable fume extractor consists of a moveable capture hood, ducting, air cleaner, fan and motor. These units are useful on large objects which cannot be moved. The system usually has several stages, the first being a coarse filter and the second being the fine air cleaner. The fine air cleaners consist of mechanical filters or electrostatic precipitators and remove particulates only. Gases are removed by a third stage usually consisting of an activated charcoal filter.

Safety Tips:

Tips given for moveable hoods are applicable to portable extractors.

- Replace the mechanical filter when efficiency decreases or according to manufacturer's recommendations.
- Clean and maintain the electrostatic precipitator according to manufacturer's recommendations. Failure to do so may cause electrical arcing and ozone gas release.
- After replacing the fine mechanical filter or cleaning the precipitator, make sure to reinstall the coarse filter in order to make the fine air cleaner last longer.
- Periodically check charcoal filters and replace as needed

Water Table

A water table consists of a shallow tank filled with water in which plasma arc cutting tips are submerged in 8 cm (about 3 in.) of water. These tables trap much of the arc light, fume, gas and noise generated during cutting.

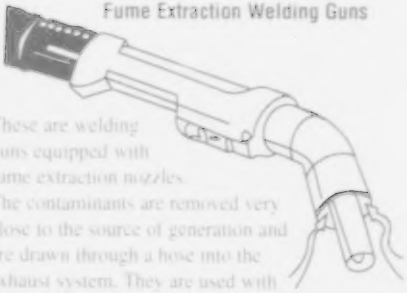
Safety Tips:

Make sure that the table is big enough to accommodate the biggest pieces you need to cut.

Make sure that the water level is above the plasma arcs.

Do not release the metal sludge in the reservoir to the sewer, as it contains heavy metals that cause environmental problems.

Fume Extraction Welding Guns



These are welding guns equipped with fume extraction nozzles. The contaminants are removed very close to the source of generation and are drawn through a hose into the exhaust system. They are used with continuous electrode processes such as GMAW and FCAW. The great advantage is that they only require about 30 to 50 cfm (0.014–0.024 m³/s) of air flow rate per welder. They can be very effective on flat and vertical surfaces or in corners and around flanges.

Safety Tips:

Repair any tears or holes in the exhaust hose to maintain efficiency.

Increase the flow of shielding gas slightly to overcome any losses due to the suction of the extraction gun.

Select a lightweight gun with a flexible swivel and lightweight hose.

Suspend the gun or hose to reduce the drag on the welder's arm.

Canopy Hood

A canopy is a capture hood placed over a welding table. Canopy hoods are suitable for providing relief from heat and humidity. They are not suitable for welding of toxic materials.

Safety Tips:

Avoid canopy hoods if welding toxic materials or creating a lot of fume.

Mount the canopy high enough to keep welders from bending over the process.

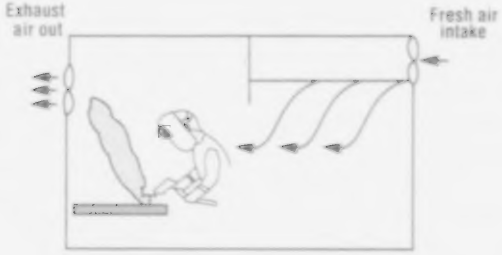
Design the canopy to overhang the dimensions of the work table by 10%.

Place a canopy hood away from traffic areas.

Place against a wall or enclose two or more sides with fire resistant curtains to limit the effect of air currents.

Dilution Ventilation for Welding Stations

Dilution ventilation can be inefficient and expensive. It moves large volumes of air and requires large air handling systems. Operating costs can be high because of the amount of air that must be heated to maintain comfort in cold weather.



Safety Tips:

- As a general rule use at least 2,000 cfm (0.95 m³/s) of ventilation for each welder. For smaller electrodes, less air volume may used. For larger electrodes use more ventilation.
- For open areas where fume can rise away from the breathing zone, use 800 cfm (0.38 m³/s) for each pound (0.45 kg) of rod used per hour.
- For open areas where the fume does not easily escape use 1,600 cfm (0.75m³/s) for each pound of rod used per hour.
- Do not use general ventilation if toxic contaminants are formed or if large amounts or if welding fumes are generated.

Air Sampling

Air sampling is monitoring airborne contaminants to determine whether or not :

- the control measures are effective in removing air contaminants
- the level of exposure is within recommended (or regulatory) exposure limits

Air sampling should be performed by a qualified industrial hygienist.

Heat and Fire

Work involving ignition sources in the vicinity of flammable materials such as welding and cutting, is referred to as "hot work" (see p.100 "Hot Work Permit"). An estimated 6% of all industrial fires are caused by cutting or welding. Sparks, hot metal, spatter, the electric arc and the cutting flame are all ignition sources which may cause nearby materials to burn or explode on contact.

Sparks, spatter and hot surfaces in welding, grinding and cutting can cause thermal burns to the skin. A piece of black metal might appear cool, but can be hot enough to cause severe burns and be a source of ignition.

Heat Ranges for Mild Steel

White Heat	1100-1600°C (2000-2900°F)
Red Heat	537-1100°C (1000-2000°F)
Black Heat	< 537°C (1000°F)

Safety Tips:

PROTECT the skin from burns by covering hot surfaces with thermal insulation.

USE a warning sign to identify hot metals.

Noise

Many activities associated with metal fabrication are noisy. Metal handling, grinding, drilling and metal-on-metal impacts are, in general, very noisy compared to most welding processes.

Typical noise levels produced by various welding processes are given below in dBA:

Welding Process	Noise Level in dBA
GTAW	50 - 60
FCAW	50 - 86
GMAW	70 - 82
Oxyfuel	<70
SMAW	62 - 82
PAW	80 - 91
Carbon Arc	96 - 116

Long-term exposure to excessive noise will result in permanent hearing loss. Short-term exposure causes annoyance and stress.

In the absence of regulated exposure limits, the ACGIH Threshold Limit Values for noise may be used.

Examples of Noise Exposure Limits

Duration Per Day (Hours)	Sound Level (dBA)
8	85
4	88
2	91
1	94
.5	97
.25	100
.125	103
No exposure permitted	> 115

Consult regulations regarding noise exposure limits applicable to your workplace.

General Safety Hazards

Welding involves a wide range of safety hazards which include handling heavy materials; working at heights; trips and falls; and falling objects.

Hoisting and Rigging

ENSURE that lift trucks, cranes, derricks and hoists are appropriate for the loads to be lifted.

MARK all cranes and hoists, with lifting capacity, manufacturer, model, serial number, year of manufacture, and hand signals for controlling hoisting operations.

ENSURE that workers understand hand signals for controlling hoisting operations.

ENSURE that all lifting devices are inspected periodically by a competent person.

ENSURE that all repairs are performed under the supervision and instruction of a professional engineer.

ENSURE that hoisting and rigging are performed and supervised by trained and qualified personnel.

ENSURE that equipment is capable of lifting the load.

USE the proper size of wire rope and ensure that it is in good condition.

USE hooks that are equipped with a safety clasp and which are not deformed.

FAMILIARIZE yourself with emergency stopping devices on cranes and hoists operated on rails.

KNOW all the standard crane signals. Only a designated person should signal the hoist operator.

DO NOT use slings made of nylon or other materials which may melt when hot.

Work at Heights

To work on elevated platforms, workers must be aware of the requirements for safe use of ladders, scaffolds and fall protection.

Ladders

FOLLOW safe ladder use procedures as established in your workplace.

SUPPORT a ladder at the bottom with ladder shoes and tie it off at the top.

FACE the ladder when ascending and descending, using both hands.

DO NOT extend a ladder away from the wall more than 1/4 of the perpendicular height of the ladder. The ladder should extend 3 feet (.9 metres) above the top of the top landing.

DO NOT stand on the top two rungs of a ladder.

DO NOT carry loads up a ladder. Use hoisting equipment.

DO NOT use metal ladders with electrical equipment or near overhead wires.

Scaffolds

ENSURE that scaffolds are constructed of approved materials and are only supporting loads for which they have been designed.

SECURE scaffold towers at vertical intervals of not more than 4.5 metres (15 feet) and horizontally at not more than 6.4 metres (21 feet).

ENSURE that rolling scaffolds do not exceed three times the dimension of the base in height.

ENSURE that scaffold platforms meet the safety requirement. Consult health and safety regulation applicable to your workplace.

- Construction scaffold platforms must be a minimum of 19 inches (48 cm) wide made from 2" x 10" (5 cm x 25 cm) planking.
- Platforms must be the full width of the scaffold at heights above 2.4 metres (8 feet).

Mobile Equipment

- [ ] BE AWARE of the mobile equipment in your area.
- [ ] WATCH for signals and warning signs.
- [ ] KEEP a safe distance from forklift trucks and other mobile equipment.
- [ ] INSTALL toeboards to prevent objects from falling.
- [ ] INSTALL handrails on open sides of scaffolds to protect workers from falling.
- [ ] PROVIDE flotation devices for workers who work above open water.
- [ ] PROVIDE full body safety harnesses and safety ropes when working at heights.

Fall Protection

A fall protection system is generally recommended when work is being done at a place

(a) from which a fall of 3 m (10 ft) or more may occur, or

(b) where a fall from lesser height involves unusual risk of injury.

- [ ] USE a full body harness.
- [ ] USE a fire resistant lifeline or lanyard. Anchor your line to a secure attachment point.
- [ ] INSPECT your line for damage and replace it if necessary.
- [ ] USE the proper length of line for your elevation length.

Housekeeping

- [ ] KEEP all working areas free of all unnecessary debris.
- [ ] REMOVE waste material daily.
- [ ] REMOVE welding stubs, off-cuts and all objects from floors which may cause slips, trips or falls.
- [ ] ABSORB all oil and grease immediately with a non-flammable absorbing material and remove promptly.

KEEP walkways and scaffolds clear of welding cables, air hoses, electrical cords, tools and equipment.

REMOVE raw materials and finished products to prevent congestion of walkways or access ways.

KEEP aisles clear so that mobile lifting aids can access loads.

Robots

Welding robots and other automatic welding equipment have become common in industry. A robot's movements may be hazardous to workers because of:

- contact with the robot,
- entrapment between the robot arm and other structures,
- legitimate work activity of the robot,
- unprogrammed movements of the robot.

The risk of injury is greatest inside the robot working envelope. This space includes all points that could be reached by the robot arm.

The risk of injury is greatest while the worker is:

- teaching (programming) the robot,
- maintaining the robot,
- clearing a jam.

A good source of information on robot safety is ANSI/RIA, R15.06, American National Standard for Industrial Robot Systems – Safety Requirements.

Planning and Installing Robot Systems

Plan for robot safety before installation:

- Use limiting devices to reduce the size of the envelope.
- Isolate operator stations.
- Provide safeguards to prevent unauthorized entry into the robot's working area.

- Install, anchor and wire the robot according to manufacturers' specifications and applicable codes.
- Ensure robot compatibility with the working environment that may be subject to explosive mixtures, dust, corrosives, humidity, temperature extremes, electromagnetic interference, and radio frequency interference.
- Provide clearance to avoid pinch points and interference with walls, pillars, structures, utility lines, other machines and equipment, etc.
- Identify the restricted work envelope by means of signs, markings or railings.

Safety Design

The design of a robot installation should incorporate safety measures:

- Provide failsafe devices to default the robot to a hazard-free condition in case of a power failure.
- Provide emergency stop devices as required and only allow the robot to be restarted from outside the restricted work envelope.
- Provide a warning light which is lit any time the robot is energized.
- Provide a default slow speed in the event of malfunction.
- Ensure that the control panel does not interfere with the operator's view of the robot.
- Locate all controls and equipment requiring access during robot operation outside the work envelope.
- Develop safe installation, operation and training procedures for all robot work areas.

Safeguarding

Safeguard devices include barriers, enclosures, warning signs, interlock gates, light beams and pressure sensitive mats. These must be positioned so that persons cannot reach or penetrate sufficiently into the working envelope before stopping the robot.

Teaching the Robot

- Teaching is the act of programming a robot to perform its work.
- The teacher must be trained on a specific installation.
- Only the teacher can be allowed in the work envelope during teaching.
- During teaching the robot must operate on slow speed only.
- Prior to initiating automated operation, the teacher must leave the work envelope.

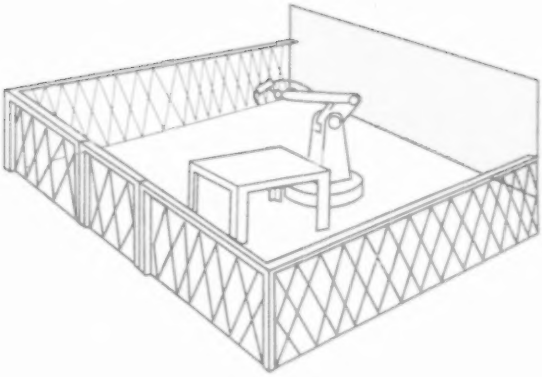
Robot Operation

OBTAIN adequate training to work in a safe manner when operating a robot.

REPORT immediately any unexpected movements of a robot.

TAG defective robots and report to your supervisors.

DO NOT operate defective robots.



Section IV

Special Welding Situations

1. Oxyfuel Welding, Cutting and Heating
2. Welding in Confined Spaces
3. Cutting of Containers
4. Hot Work Permit

1. Oxyfuel Welding, Cutting and Heating

Oxyfuel Gas Equipment

Oxyfuel gas equipment is used for cutting and heating. It has been mostly replaced by electric arc processes for welding, although it is still used for brazing and soldering.

Oxyfuel gas equipment consists of cylinders of compressed oxygen and fuel gases, regulators, flash back arresters or, alternatively, reverse flow check valves, gas delivery hoses, oxyfuel torch and cutting, heating or welding tip. An oxyfuel gas apparatus is shown on page 24.

In the oxyfuel process, oxygen gas is combined with a fuel gas to produce a flammable gas mixture which is ignited to produce an intense burning. Oxyfuel equipment is potentially very hazardous in the hands of an untrained worker, because of the risk of fire or an explosion.

Fuel Gas Properties

Three important properties of fuel gases must be understood: vapour density; flammable or explosive range; and lower and upper flammable limits.

Vapour Density

Vapour density is the weight per unit volume of a pure gas or vapour. On an MSDS, the vapour density is commonly given as the ratio of the density of a gas or vapour to the density of air. The density of air is given a value of 1. Light gases (vapour density less than 1) such as helium rise in air. If there is inadiquate ventilation, heavy gases (vapours density greater than 1) can accumulate in low-lying areas such as pits and along floors.

Vapour Density of Common Fuel Gases

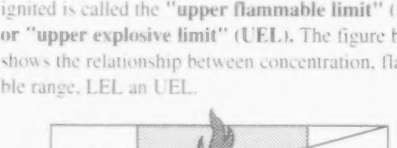
Leaking acetylene tends to rise to the ceiling, and if an ignition source were present, it could ignite. Leaking propane will fall to the ground where it could be ignited by falling sparks or spatter.

Vapour	Vapour Density relative to air
Natural Gas	0.55
Acetylene	0.91
Air	1.00
Propane	1.56
Butane	2.05

Typical **ignition sources** include welding arcs, open flames, hot surfaces, slag or spatter, welding sparks, grinding sparks, electrical sparks, lit smoking materials, and electrostatic discharges.

Flammable or Explosive Limits

The lowest concentration of a substance mixed in air which can be ignited is called the **"lower flammable limit" (LFL) or "lower explosive limit" (LEL).** These terms are used interchangeably. The highest concentration of a substance mixed in air which can be ignited is called the **"upper flammable limit" (UFL) or "upper explosive limit" (UEL).** The figure below shows the relationship between concentration, flammable range, LEL an UEL.



All flammable gases and vapors have different flammable ranges

At concentrations below LFL there is too little fuel to ignite as the mixture is "too lean." At concentrations above UFL, there is too little air and the mixture is "too rich" to ignite. Each fuel gas has a specific flammable range.

Substance	LEL or LFL (% in air)	UEL or UFL (% in air)
Acetylene	2.3	80
Hydrogen	4	75
Natural Gas	3.8	17
Propane	2.1	9.5

Oxygen

Air normally contains 21% oxygen. If the oxygen content is elevated, because of a leak from an oxygen cylinder, substances will burn much more rapidly.

Safe Storage of Compressed Gas Cylinders

- ☑ CHECK your fire code for guidelines regarding storage of flammable gas cylinders.

STORE cylinders in a clearly identified, dry, well ventilated storage area away from doorways, aisles, elevators, and stairs.

POST "no smoking" signs in the area.

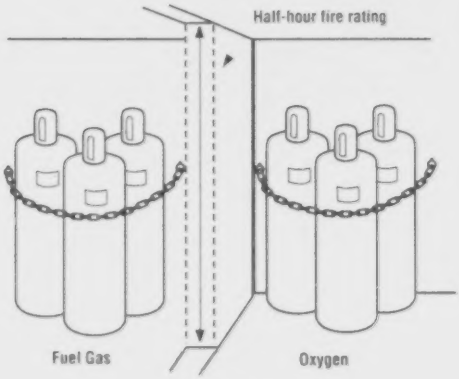
STORE cylinders in the upright position and secure with an insulated chain or non-conductive belt.

ENSURE that the area is well ventilated. With outside storage, place on a fire-proof surface and enclose in a tamper-proof enclosure.

STORE oxygen and fuel gases separately. Indoors, separate oxygen from fuel gas cylinders by at least 6 metres (20 feet), by a wall at least 1.5 m (5 ft) high, or rated for 1.5 hour fire resistance.

SECURE the protective caps.

PROTECT cylinders from contact with ground, ice, snow, water, salt, corrosion, and high temperatures.



Storage of Gases

DO NOT USE a cylinder as an electrical ground connection. Do not fasten cylinders to a work table or to structures where they could become part of an electrical circuit.

DO NOT STRIKE an arc on a cylinder.

DO NOT USE a flame or boiling water to thaw a frozen valve. Valves or cylinders may contain fusible plugs which can melt at temperatures below the boiling point of water.

Out of Service Cylinders

☑ MARK and store empty cylinders away from full cylinders.

RETURN empties to the supplier.

REMOVE regulators when not in use and store these away from grease and oil. Put protective caps on the fittings when in storage.

KEEP cylinders and fittings from becoming contaminated with oil, grease or dust.

☒ DO NOT USE a cylinder that is not identified or if the label is not legible. The colours of industrial gas cylinders are not standardized.

Moving Cylinders

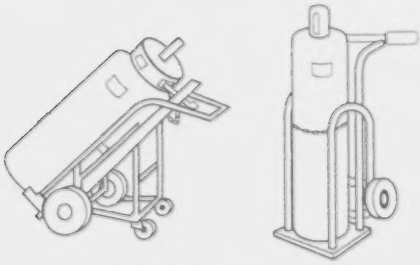
☑ REMOVE regulator before moving.

MOVE cylinders with caps in place.

MOVE cylinders with appropriate trolleys. Use proper lifting cradles.

CALL the supplier to remove leaky cylinders immediately.

☒ DO NOT LIFT a cylinder by the valve cap. Never sling with ropes or chains or lift with electromagnets.



Cylinder Trolleys

DO NOT drag, slide, or drop cylinders. They can be rolled for short distances on their base.

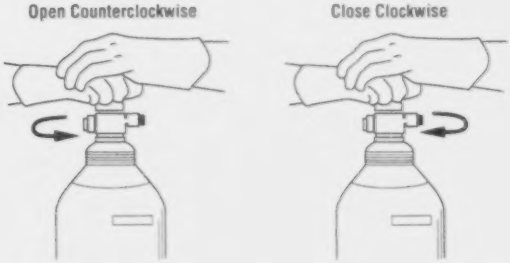
NEVER place cylinders on their sides as rollers to move equipment.

DO NOT try to refill a cylinder or mix gases in a cylinder.

Cracking Cylinders

☑ BEFORE attaching the regulator, "crack" a secured cylinder by opening the valve slightly then closing it immediately to blow out dust or dirt. Use two hands on the valve, and never stand directly in front of or behind the valve.

☒ DO NOT crack fuel gases near ignition sources. Never crack hydrogen cylinders since the release of compressed hydrogen may ignite by itself.



Cracking of Cylinder

Regulators

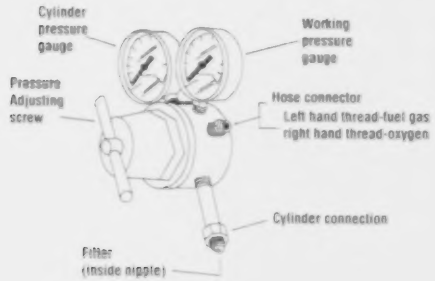
☑ USE the correct regulator for the gas being used.

MAKE sure that the regulator is clean and free of grease or oil, with a clean filter on the inlet nipple.

ACETYLENE and propane regulators have the same fitting. Never mount a propane regulator onto an acetylene cylinder because the operating pressure of the acetylene regulator must never exceed 103 kilo Pascals (kPa) or 15 pounds per square inch (PSI). The propane regulator can be set and is used above 15 PSI.

REGULATORS removed from cylinders must always be stored with protective caps on the fittings.

Typical Gas Regulator



Reverse Flow Prevention

☑ INSTALL reverse flow check valves at either end of both the fuel and oxygen hoses.

CHECK VALVES provide some protection against back flow but not against a flashback. They can become dirty with time and may need to be replaced. Refer to the supplier's instructions for replacement frequency.

CHECK valves restrict the flow of gas. Refer to the manufacturer for advice about setting correct gas pressures for your application.

Flashback Arresters

Flashback arresters are generally preferred over reverse flow check valves because they can stop a flashback and also stop a flow reversal. They may be mounted on the torch or on the regulator.

Refer to the manufacturer's instructions concerning where to mount th arrestor, replacement frequency, testing and suitability in specific applications.

In some jurisdictions, flashback arresters are mandatory. Verify your local requirements with the authority having jurisdiction in your area.

Gas Hoses and Connections

Oxygen hoses are green with right-hand thread connection.

Fuel gas hoses are red with left-hand thread connection, and the nut is grooved to indicate the left-hand thread.

☑ USE the correct hoses and fittings.

CHECK hoses for damage, cracks, holes and brittleness before use.

REPLACE damaged or leaking hoses.

USE the right length of hose for your needs and avoid hoses longer than necessary. Avoid kinks in the hose.

TEST for leaks with a non-soap leak test solution.

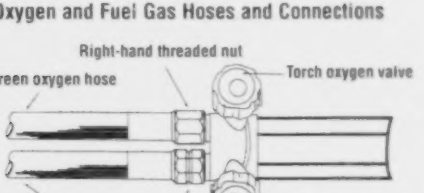
ENSURE fittings are clean and free or greases or oil.

☒ ALWAYS flush hoses after replacing.

DO NOT tape leaky hoses.

DO NOT force the connections. Tighten nuts with the intended wrench after first finger tightening.

Oxygen and Fuel Gas Hoses and Connections



Opening Cylinder Valves

☑ BACK OFF the regulator pressure adjusting screw by turning it counterclockwise until it turns freely, before opening the cylinder valve. This will prevent damage or a fire from a sudden compression and rapid heating of gas.

STAND to one side of a cylinder, not in front of it, when opening the valve.

OPEN cylinder valve slowly. When the high pressure gauge indicates maximum pressure, open the cylinder valve fully if it is a backstop valve.

USE the proper valve wrench and leave it in place to permit an emergency shut off if necessary.

Operating Settings

Refer to the manufacturer's operating chart for the correct fuel-gas and oxygen working pressure settings.

Equipment Shutdown

Follow the gas shutdown sequence recommended by the manufacturer.

☑ CLOSE valves at the torch followed by the cylinder valve.

DEPRESSURIZE the gas lines by opening the torch valves and releasing the pressure in the lines. Close the torch valves again. Next, back off the pressure adjusting screw on the regulator.

MAKE SURE that the inlet gauge pressure is at zero and that the cylinder valve is closed before leaving.

Common Safety Problems

Improper use of the oxyfuel gas torch can lead to several safety problems including backfire, sustained backfire and flashback.

Backfire occurs when the flame returns into the tip followed by flame out due to insufficient gas flow at the tip. A backfire is accompanied by popping sounds. Check for inadequate pressure, leaking hoses, blocked tip, etc. before resuming work.

Sustained backfire occurs when the flame travels back into the torch and burns continuously at or near the point of mixing. It is accompanied by a loud hissing or squealing noise. If a sustained backfire occurs, shut off the torch immediately. Follow the manufacturer's instructions. Let the torch cool. Check the hoses, cylinders, and regulators for damage and replace or repair any damaged components.

Flashback occurs when the flame travels back through the torch to the cylinders due to overheating of the torch head or insufficient gas pressure.

- ☑ CLOSE both the fuel gas and oxygen cylinder valves.
- INSPECT the apparatus and determine the cause of the flashback.
- REPLACE any damaged components before relighting the equipment.
- USE a flashback arrester mounted on both regulators or on the gas supply lines at the torch to reduce risk of a flash back
- CONTACT the manufacturer for the proper flashback arrester for your application.

2. Welding in Confined Spaces

Welding operations may occur inside "confined spaces" in all aspects of manufacturing, construction and maintenance. Confined spaces can be dangerous in themselves. Welding inside these can rapidly add to the potential hazards through the emission of toxic or flammable substances, sudden oxygen displacement, the presence of electrical hazards, heat stress and arc light reflections.

Recognizing Confined Spaces

It is extremely important to make sure that the confined space is checked for the presence of asphyxiants and flammable gases. When welding in a confined space, you risk incurring fatal burns or suffocation.

A confined space is characterized by criteria such as the following:

- not designed or intended for human occupancy
- restricted access or egress
- inadequate ventilation due to its design, internal structure or intended application
- possibility of oxygen deficiency, displacement or enrichment
- possibility of flammable or toxic vapours, gases or particulates to accumulate.

You can find the legal definition of confined space in your health and safety legislation.

Preparing for Confined Space Welding

The preparations for welding in a confined space are similar to those needed for most types of work in confined spaces.

Isolate

- Turn off pressurized systems and mechanical linkages and lock out electrical supplies at the power source. Follow plant procedures for lockout and tagout of equipment.

Clean

☑ EMPTY and clean the space to ensure that no hazardous materials remain in it.

FLUSH, blow out, clean or purge pipes and ducts.

CLEAN the space with a cleaning process appropriate for the contaminants in the space. Ensure that cleaning products are properly discarded.

PERFORM any work that can be done from the outside prior to entry if possible.

Ventilate

Follow procedures established by your company.

☑ VENTILATE as required to remove toxic or flammable contaminants. Ensure adequate oxygen in the air.

CALCULATE the volume and duration of ventilation needed to completely remove hazards and restore a breatheable atmosphere. Ensure that the ventilation system runs without interruption.

VENTILATE with fresh air. Do not use oxygen to "sweeten" the air.

TEST the air thoroughly before permitting entry.

Air Monitoring

- ☑ TEST the air in the space before entry is permitted.

CONTINUE to ventilate while site preparation and welding work are performed.

WEAR respiratory protection appropriate to the task and the air contaminants.

Fire Prevention

Refer to the precaution to take when welding or cutting near combustible materials on page 101

Planning an Emergency Rescue

Prior to welding in a confined space, plan for contingencies in the event of an emergency.

- ☑ ASSIGN responsibility to trained attendants and rescue team members.

ENSURE team members must be physically fit and have good strength and endurance.

TRAIN team members in first aid, cardiopulmonary resuscitation (CPR), communication, use of personal protective equipment and rescue equipment, rescue techniques and self-rescuing.

PROVIDE rescuers with their own separate respiratory protection, safety and rescue equipment, fall protection devices, communication equipment, equipment and victim transport, and fire extinguishers.

Confined Space Entry Permits

An entry permit is issued by a competent, authorized person who is completely familiar with the work or situation covered by the permit and has control over that work area.

The issuer must ensure that the work situation is as

described on the work permit. The issuer must review the operation with the worker before work starts.

The recipient of the permit must be competent and must fully understand the work situation, the potential hazards and the precautions needed before accepting the permit. Any special precautions above and beyond those usually taken for the work must be identified to the permit recipient.

Provide copies of entry permit to the issuer and the person doing the work.

On completion of work, the worker copy is returned to the issuer at the end of the work permit validity period.

3. Cutting of Containers

Before welding or cutting:

☑ IDENTIFY the previous contents of the container and their toxic and flammable hazards (consult the material safety data sheets and WHMIS labels).

TEST for the presence of combustible materials.

CLEAN the container thoroughly by steaming or water washing.

During the actual welding or cutting, the following precautions must be taken:

☑ FILL the container with water to within a few inches of the point where the welding or cutting is to be done.

VENT the space above the water to allow the heated air to escape.

TEST the vented gases for combustible or toxic components. If you detect any, stop welding or cutting.

AVOID explosion from expansion of trapped gases.

☒ DO NOT weld near unvented pockets such as lap patches or seams, reinforcing pads or jacketed containers.

Refer to AWS (American Welding Society) Standard F 4.1 for further information.

4. Hot Work Permit

Work involving ignition sources in the vicinity of flammable materials is referred to as "hot work." Welding and cutting are examples of hot work. Fires often are the result of the "quick five minute" job in areas not intended for welding or cutting. No precautions are taken and, within minutes, sparks or hot material can start a fire.

The National Fire Protection Association (NFPA) Standard 51B "Fire Prevention in the Use of Cutting and Welding Processes" serves as the basis for the fire codes and for many practices adopted by industry.

Precautions to Take When Cutting or Welding Near Combustible Materials

- ☑ ENSURE that all equipment is in good operating order before work starts.
- INSPECT the work area thoroughly before starting. Look for combustible materials in structures (partitions, walls, ceilings).
- SWEEP clean any combustible materials on floors around the work zone. Combustible floors must be kept wet with water or covered with blankets or damp sand.
- USE water only if electrical circuits have been de-energized to prevent electrical shock.
- MOVE all combustible materials away from the work area.
- COVER combustibles with fire resistant blankets or shields if such materials cannot be moved.
- PROTECT gas lines and equipment from falling sparks, hot materials and objects.
- BLOCK off cracks between floorboards, along baseboards and walls, and under door openings, with a fire resistant material. Close doors and windows.
- COVER wall or ceiling surfaces with a fire resistant and heat insulating material to prevent ignition and accumulation of heat.
- INSPECT the area following work to ensure that wall surfaces, studs, wires or dirt have not heated up.
- VACUUM away combustible debris from inside ventilation or other service duct openings to prevent ignition.

PREVENT sparks from entering into the duct work. Cover duct openings with a fire resistant barrier and inspect the ducts after work has concluded.

POST a trained fire watcher within the work area during welding and for at least 30 minutes after work has stopped.

COMPLY with the required legislation and standards applicable to your workplace.

Section V

Personal Protective Equipment

1. PPE Checklist
2. Respirators
3. Safety Glasses
4. Safety Footwear
5. Headwear
6. Hearing Protection

1. Personal Protective Equipment (PPE) Checklist

Yes	No	
☐	☐	Have you received training in the usage of PPE?
☐	☐	Is appropriate PPE made available to you?
☐	☐	Is your PPE certified for its intended use by a standards authority (such as CSA, CGSB, NIOSH, ANSI)?
☐	☐	Does your PPE fit properly?
☐	☐	Do you know how to test that PPE is being worn properly (for example, respirator fit testing)?
☐	☐	Do you or your health and safety committee or representatives review the PPE rules and procedures?
☐	☐	Do you or your health and safety committee or representatives help identify the needs for PPE?
☐	☐	Do you review MSDSs and labels when working with chemicals to find out what PPE is required?
☐	☐	Are you using the PPE as prescribed?
☐	☐	Have you been instructed on how to properly care for and maintain your PPE?
☐	☐	Do you have proper storage and cleaning facilities?
☐	☐	Do you return used or damaged equipment in order to receive a reissue?
☐	☐	Does your supervisor check PPE to ensure that it is serviceable?
☐	☐	Does your workplace annually review usage in order to reevaluate the need for the selection and use of PPE?
☐	☐	Do you use the PPE required by government regulations and company policy for the jobs you perform?
☐	☐	Do you follow your organization's written PPE policy for specific jobs?

Cap
Ear protection
Safety glasses
Helmet
Insulated gloves
No cuffs
Rubber-soled safety shoes
Steel
Heat resistant jacket

Protective Clothing and Equipment

- ☑ WEAR clothing made from heavyweight, tightly woven, 100% wool or cotton to protect from UV, hot metal, sparks and open flames. Flame retardant treatments become less effective with repeated launderings.
- KEEP clothing clean and free of oils, greases and combustible contaminants.
- WEAR long-sleeved shirts with buttoned cuffs and a collar to protect the neck. Dark colours prevent light reflection.
- TAPE shirt pockets closed to avoid collecting sparks or hot metal or keep them covered with flaps.
- PANT legs must not have cuffs and must cover the tops of the boots. Cuffs can collect sparks.
- REPAIR all frayed edges, tears or holes in clothing.
- WEAR high top boots fully laced to prevent sparks from entering into the boots.
- USE fire resistant boot protectors or spats strapped around the pant legs and boot tops, to prevent sparks from bouncing in the top of the boots.
- REMOVE all ignition sources such as matches and butane lighters from pockets. Hot welding sparks may light the matches or ignite leaking lighter fuel.
- WEAR gauntlet-type cuff leather gloves or protective sleeves of similar material, to protect wrists and forearms. Leather is a good electrical insulator if kept dry.
- DIRECT any spark spray away from your clothing.
- WEAR leather aprons to protect your chest and lap from sparks when standing or sitting.
- DRESS in removable clothing layers to prevent sweating. Sweaty clothes cause rapid heat loss. Leather welding jackets are not very breathable and can make you sweat if you are overdressed.
- AVOID overdressing in cold weather.

WEAR a fire-resistant skull cap or balaclava hood under your helmet to protect your head from burns and UV.

WEAR a welder's face shield to protect your face from UV and flying particles.

DO NOT wear rings or jewellery.

DO NOT wear clothing made from synthetic or synthetic blends. The synthetic fabric can burn vigorously, melt and produce bad skin burns.

2. Respirators

Respiratory protection is needed when ventilation is not sufficient to remove welding fumes or when there is risk of oxygen deficiency.

Using Respirators

- Select and use respirators in compliance with your workplace regulation.
- Seek expert advice and initiate a proper respiratory protection program.

Respirators are of two basic types: air-purifying respirators and air-supplying respirators. For each type a number of styles are available, including half and full facepiece masks. The selection of the proper respirator depends on the type of work being performed, the amount of contaminant produced and the concentrations, toxicity, and permissible exposures to harmful substances in the air. The process of selecting appropriate respiratory protection is outlined in CSA Z94.4 and ANSI Z88.2 standard "Respiratory Protection".

Air-Purifying Respirators

For situations involving exposure to moderate amounts of non-toxic welding fumes, air-purifying respirator masks provide adequate protection. **They do not offer any protection if the atmosphere is low in oxygen or contains hazardous gases.**

Disposable, single-use dust masks give limited protection from welding fume and are not generally recommended, particularly when the fume has toxic components. Multi-use respirators consist of a facepiece with replaceable filter cartridges that remove particulate matter such as fumes and dust. The mask may be a half or full facepiece and to be effective requires a good seal around the rim; beards and moustaches do not allow a proper seal.

Air-Supplying

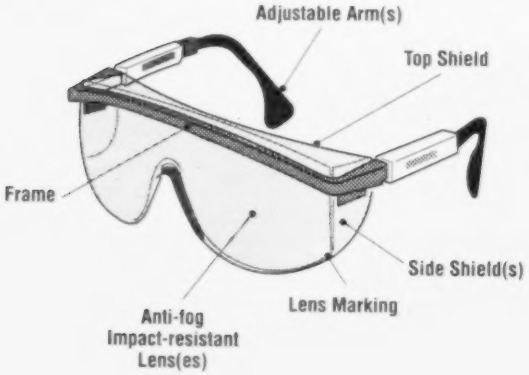
Air-supplying respirators are the preferred system since they supply you with clean air. These respirators provide breathing air from a remote source. For extreme conditions, various types of self-contained breathing apparatus (SCBA) are available.

3. Safety Glasses

How to Recognize Safety Eyewear

For selection of appropriate eyewear refer to CSA standard Z94.3, "Industrial eye and face protection". In the USA refer to ANSI Z88.2 standard "Respiratory protection". Eye protection for welding must provide protection against chemicals, flying objects, ultraviolet radiation (UV Rays), intense light and infrared (heat) radiation. CSA (ANSI in the US) certified safety eyewear come in prescription and non-prescription (plano) forms. All approved safety lenses are marked with the manufacturer's logo.

Safety frames are stronger than streetwear frames and often heat resistant. They are designed to prevent lenses from being pushed into the eyes. All CSA certified safety frames have the imprint "Z94.3" stamped on them and may have the CSA logo imprinted on the temple.



Correct Fit of Safety Glasses

☑ ENSURE your safety glasses fit properly. They need to be individually assigned and fitted because eye size, bridge size and temple length all vary from person to person.

WEAR safety glasses so that the temples fit comfortably over the ears. The frame should be as close to the face as possible and adequately supported by the bridge of the nose.

ENSURE that safety glasses do not interfere with your vision.

Proper Care of Safety Glasses

Safety glasses require regular maintenance.

☑ CLEAN your safety glasses daily according to manufacturer's instructions. Avoid scratching the lenses. Scratches impair vision and can weaken glass lenses.

STORE your safety glasses in a clean, dry place where they cannot fall or be stepped on. Keep them in a case when they are not being worn.

REPLACE scratched, pitted, broken, bent or ill-fitting glasses. Damaged glasses interfere with vision and do not provide adequate protection.

4. Safety Footwear

Impact, compression and puncture are the most common types of foot injury. Safety footwear is designed to protect feet against these injuries.

☑ CHOOSE footwear according to the hazard. In Canada, refer to CSA Standard Z195 "Protective Footwear." In the USA refer to ANSI Standard Z41-1991.

SELECT CSA certified footwear. Ensure that it has the proper rating for the hazard and the proper sole for the working conditions.

WALK in new footwear to ensure it is comfortable.

LACE up boots fully. High-cut boots provide support against ankle injury.

USE a protective coating to make footwear water-resistant.

USE metatarsal protection (top of the foot between the toes and ankle) where there is a potential for injury.

INSPECT footwear regularly for damage.

REPAIR or replace worn or defective footwear.

Suggested Protective Footwear

Grade I will withstand 50 lb (23 kg) weight dropped from a height of 22 in (56 cm).

Green

Combined with:

for punctures,

for high voltage

This grade of boot is suitable for workers in the following fields:

- warehousing
- machine shops
- auto industries
- aircraft industries
- paint companies
- home appliances
- fire departments

Grade II will withstand 50lb (23 kg) weight dropped from a height of 16 in (41 cm)

Yellow

Combined with:

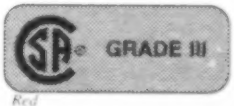
for punctures,

for high voltage

This grade of boot is suitable for workers in the following fields:

- freight companies
- steel mills
- construction
- mining
- auto industries
- paper mills
- lumbering

Grade III will withstand 50 lb (23 kg) weight dropped from a height of 10.5 in (26 cm).



Red

Combined with:

for punctures,

for high voltage

This grade of boot is suitable for workers in the following fields:

- light manufacturing
- retail stores
- security
- ambulance staff
- hospitals
- service stations
- office staff

5. Headwear

Headwear consists of a shell and suspension. These work together as a system, and both need regular inspection and maintenance.

☑ CHOOSE the correct headwear for the job. In Canada refer to CSA Standard Z94.1, Industrial Protective Headwear.

Type I – Hat (full brim)

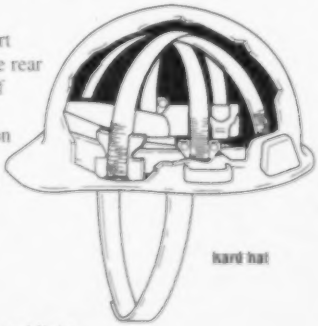
Type II – Cap (with or without peak)

Class A – General use, limited voltage protection

Class B – High voltage protection

Class C – General use, metallic no voltage protection

☒ DO NOT transport headwear on the rear window shelf of vehicles. In an accident situation it could fly forward and hit you, causing serious injury.



hard hat

Shell

The shell is rigid and light, and is shaped to deflect falling objects. Correct maintenance is important.

☑ INSPECT AND REPLACE a shell that shows signs of cracks, wear, scratches or gouges. Shells exposed to heat, sunlight and chemicals can become stiff or brittle.

REPLACE headwear that has been struck, even if no damage is visible.

REMOVE AND DESTROY any headwear if its protective abilities are questionable.

DO NOT drill holes, alter or modify the shell. Alterations may reduce the protection provided by the headwear.

DO NOT paint the plastic shell. Paint solvents can make plastic headwear brittle and more susceptible to cracks. Instead, use reflective marking tape to make numbers or symbols for identification purposes. Metal headwear may be painted.

DO NOT use winter liners that contain metal or electrically conductive material.

DO NOT draw the chin strap over the brim or peak of Class B headwear.

Suspension

The suspension system is as important as the shell. It holds the shell away from the head and acts as a shock absorber. It also holds the shell in place on the head and allows air to flow freely.

ADJUST headband size so that headwear will stay on when wearer is bending over, but not so tight that it leaves a mark on the forehead.

ENSURE that the suspension is in good condition. The main purpose of the suspension is to absorb energy. Look closely for cracked or torn adjustment slots, frayed material or other signs of wear.

CHECK suspension lugs carefully. Perspiration and hair oils can cause wear. Long periods of normal use can damage the suspension.

REPLACE suspension that has torn or broken treads.

DO NOT put anything inside headwear. There must be a clearance inside the headwear while it is being worn. In the event of a blow to the head, that space helps absorb the shock. DO NOT wear the headwear with the visor pointing backward, or the suspension will not provide the intended protection.

Maintenance and Inspection

Headwear must be cared for and maintained in order to protect as designed. Its life span is affected by normal use and by heat, cold, chemicals and ultraviolet rays.

☑ CLEAN the suspension and shell regularly.

USE a wet sponge or soft brush with mild dish detergent and thoroughly rinse with water to remove dirt and stains.

6. Hearing Protection

Hearing protectors reduce the amount of sound energy reaching the ears. Their effectiveness depends on proper fit and regular use.

Earplugs are inserted to block the ear canal. They may be premolded (preformed) or moldable (such as glass down, foam plastic, waxed cotton).

Canal caps consist of two earplugs held over the ends of the ear canal by a rigid headband.

Earmuffs consist of a sound attenuating material, soft ear cushions which fit around the ear, and hard outer cups. Earmuffs are held in place by a headband.

The noise reducing capability of hearing protectors is given as NRR (Noise Reduction Rating). To determine the amount of noise reduction subtract 7 from the given NRR. (i.e. a hearing protector with a NRR of 20 will provide a maximum noise reduction of 13 dB(A)). Under conditions of actual use hearing protectors provide lesser protection than that calculated using the

NRR provided the manufacturer. In absence of subject fit data, NIOSH recommends that the labeled NRRs be deraated as follows:

Earmuffs

Subtract 25% from the manufacturer's labeled NRR

Formable earplugs

Subtract 50% from the manufacturer's labeled NRR

All other earplugs

Subtract 70% from the manufacturer's labeled NRR

To determine the effective noise reduction subtract 7 from the derated NRR

Select hearing protection that is:

- correct for the job.
- capable of adequately reducing sound level. Check manufacturer's literature;
- comfortable enough to be worn during all exposure to noise.

DO NOT use radio headsets as a substitute for hearing protection.

DO NOT modify hearing protectors.

In Canada refer to CSA Standard Z94.2, "Hearing Protectors". In the USA refer to appropriate OSHA standard 29 CFR 1910.95, Occupational Noise Exposure

COMPARISION OF HEARING PROTECTION

Earplugs	Earmuffs
Advantages • Small and easily carried. • Convenient to use with other personal protective equipment (can be worn with earmuffs). • More comfortable in hot, humid work areas. • Convenient for use in confined work areas.	**Advantages** • Less attenuation variability among users. • Designed so that one size fits most head sizes. • Easily seen at a distance to assist in the monitoring of their use. • Not easily misplaced or lost. • May be worn with minor ear infections.
Disadvantages • Require more time to fit. • Difficult to insert and remove. • May irritate the ear canal. • Easily misplaced. • More difficult to see and monitor usage. • Get dirty when your hands are dirty.	**Disadvantages** • Heavier, less portable • Inconvenient for use with other personal protective equipment. • Uncomfortable in hot, humid work areas. • Inconvenient for use in confined work areas. Seals may be broken by safety glass.

Proper Fit of Hearing Protection

FOLLOW manufacturer's instructions.

MAKE SURE your hands are clean before handling ear plugs.

ENSURE ear plugs tightly seal within the ear canal. If you use earmuffs, they should fit snuggly against the side of the head

Section VI

Occupational Health and Safety Legislation

Canadian Occupational Health and Safety Legislation

1. **What Does the OH&S Legislation Say?**
   - Government's Responsibilities
   - Worker's Rights and Responsibilities
   - Supervisor's Responsibilities
   - Employer's Responsibilities
   - Formation of Joint Health and Safety Committee
   - Role of Joint Health and Safety Committee
   - Work Refusals
2. **Workplace Hazardous Material Information System (WHMIS)**
   - Hazard Symbols and Classes
3. **Fire Code**
4. **Building Code**

US Occupational Health and Safety Legislation

- General Outline
- Duties of Employer
- Duties of Employee
- Key Provisions
- Hazard Communication
- Hazard Warning Symbols

Canadian Occupational Health and Safety Legislation

The purpose of Occupational Health and Safety (OH&S) legislation is to protect employees against hazards on the job. It outlines the general rights and responsibilities of the employer, the supervisor and the employee.

The law makes both you and your employer responsible for workplace health and safety.

1. What does the OH&S legislation say?

Each of the provinces and the federal government have their own OH&S legislation. The details of the OH&S legislation vary slightly from one jurisdiction to another, but the basic elements are the same. These basic elements include the following:

Government's Responsibilities

i) to develop and enforce occupational health and safety legislation

ii) to conduct workplace inspections

iii) to disseminate information

iv) to promote training, education and research

Worker's Rights

i) to refuse unsafe work

ii) to participate in the workplace health and safety activities through Joint Health and Safety Committee (JHSC) or worker health and safety representative

iii) to know actual and potential dangers in the workplace

Worker's Responsibilities

i) to work in compliance with OH&S act and regulations and company policy

ii) to use personal protective equipment and clothing as directed by the employer

iii) to report workplace hazards and dangers

iv) to participate in OH&S training

Supervisor's Responsibilities

i) to advise workers of potential and actual hazards

ii) to take every reasonable precaution in the circumstances for the protection of workers

iii) to ensure that workers use prescribed protective equipment devices

Employer's Responsibilities

i) to take every reasonable precaution to ensure workplace is safe

ii) to establish and maintain a joint health and safety committee, or cause workers to select at least one health and safety representative

iii) to consult with and cooperate with the joint health and safety committee or worker health and safety representative

iv) to train employees about any potential hazards

v) to supply personal protective equipment and ensure workers know how to use the equipment safely and properly

vi) to immediately report all critical injuries to the government department responsible for OH&S

vii) to train all employees on how to safely use, handle, store and dispose of hazardous substances and handle emergencies

Joint Health and Safety Committee

i) must be composed of one half management and at least one half labour representatives

ii) must meet regularly according to time intervals specified in the health and safety legislation.

iii) must be co-chaired by one management chairperson and one worker chairperson

iv) employee representatives are elected or selected by the workers or their union

Role of Joint Health and Safety Committee

i) to act as an advisory body
ii) to identify hazards and obtain information
iii) to recommend corrective actions
iv) to assist in resolving work refusal cases
v) to participate in accident investigations and workplace inspections

Work Refusals

You can refuse work if you have reason to believe that the situation is unsafe to either yourself or your co-workers.

i) You must report to your supervisor that you are refusing to work and state why you believe the situation is unsafe.
ii) You, your supervisor, and a JHSC member or worker representative will investigate.
iii) You return to work if the problem is resolved.
iv) If the problem is not resolved, a government health and safety inspector is called.
v) Your supervisor may assign you reasonable alternative work.
vi) Inspector investigates and gives decision.
vii) You are protected from discipline or any other reprisal from your right to refuse unsafe work.

2. Workplace Hazardous Materials Information System – WHMIS *(Pronounced whimiss)*

WHMIS applies to all Canadian workplaces. It requires that all workers who work with or near a hazardous substance (controlled product) be informed about its potential hazards and recommended safe work practices.

WHMIS requires that information be provided in three ways:

1. All controlled products used in the workplace must have a WHMIS label on the container.
2. Material Safety Data Sheets (MSDS) and hazard information must be readily available in the work place. An MSDS summarizes the health and safety information about the product.
3. Workers must receive training to be able to recognize and work safely with chemicals. The employer must consult the joint health and safety committee to select a suitable training program.

The HAZARD SYMBOL is an important part of the WHMIS label. It warns the user that a particular hazard exists.

Actual hazards from toxic substances depend on the amount (level and duration) of exposure. A brief exposure at high levels may result in chemical poisoning within hours. Prolonged exposure at low levels may cause illness after several years.

WHMIS SYMBOLS AND CLASSES

CLASS A Compressed Gas	Contents under high pressure. Cylinder may explode or burst when heated, dropped or damaged.
CLASS B Flammable and Combustible Material	May catch fire when exposed to heat, spark or flame. May burst into flames.
CLASS C Oxidizing Material	May cause fire or explosion when in contact with wood, fuels and other combustible material.
CLASS D, Division 1 Poisonous and Infectious Material: *immediate and serious toxic effects*	Poisonous substance. A single exposure may be fatal or cause serious or permanent damage to health.
CLASS D, Division 2 Poisonous and Infectious Material: *other toxic effects*	Poisonous substance. May cause irritation. Repeated exposure may cause cancer, birth defects, or other permanent damage.
CLASS D, Division 3 Poisonous and Infectious Material: *biohazardous infectious material*	May cause disease or serious illness. Drastic exposures may result in death.
CLASS E Corrosive Material	Can cause burns to eyes, skin or respiratory system.
CLASS F Dangerously Reactive Material	May react violently causing explosion, fire or release of toxic gases, when exposed to light, heat, vibration or extreme temperatures.

3. Fire Code

The fire code sets the requirements for fire prevention and protection. These include requirements for:

i) building design complementing the building code

ii) fire protection and fire detection systems

iii) storage of specific materials

iv) fire inspections

Authority

The Fire Code is enforced by the local fire department in your city.

Information and Training

Contact your local fire department for additional information and employee education in fire safety procedures.

4. Building Code

The building code sets standards and guidelines for buildings, structures and systems. Heating, ventilation, storage, renovations, and maintenance requirements are part of the Building Code.

The objective of the Building Code is to make sure that:

i) buildings are structurally adequate for their planned use

ii) structures and materials can withstand temperature extremes and ice and snow loads

iii) building design meets fire safety code, electrical safety code and other regulatory requirements

iv) building is suitable for the planned occupancy

Information

Contact your employer or the city for information regarding the building code applicable to your workplace.

U.S. Occupational Health and Safety Legislation

General Outline

In the United States of America (USA) the Occupational Safety and Health Act is popularly known as OSHA Act. The Occupational Safety and Health Administration (OSHA) is responsible for administering the OSHA Act.

The OSHA ACT does not cover the following four categories of people:

- self-employed persons
- farms which employ only immediate family members of the farm employer
- workers covered by other legislation
- state and local government employees

Regulations dealing with OSHA are published in Title 29 of the Code of Federal Regulations as:

29 CFR Part 1910 Occupational Safety and Health Standards

29 CFR Part 1926 Construction Standards

These standards define exposure limits, exposure monitoring methods, medical surveillance and protective measures.

Duties of Employer

The OSHA Act sets out two main duties for employers:

- Employers must provide a workplace which is free from hazards that are known to cause or likely to cause death or serious physical harm to employees.
- Employers must comply with occupational safety and health standards under the Act.

Duties of Employee

Employees must comply with occupational safety and health standards, rules, regulations and orders which are applicable to their own conduct and actions.

Key Provisions

Some Key Provisions of the OSHA Act

- to assure, insofar as possible, that every employee has safe and healthy working conditions
- to require employers to maintain accurate records of exposures to potentially toxic materials or harmful physical agents and inform employees of the monitoring results
- to allow at least one employee representative to be present during the walkaround inspection
- to encourage free and open exchange of information between employees and the inspector
- to implement procedures for investigating alleged violations, at the request of any employee or employee representatives, issuing citations and assessing monetary penalties against employers

Hazard Communication

The intent of the OSHA Hazard Communication Standard is to provide employees with information and training about the potential health hazards from exposure to workplace chemicals. The Standard requires that employee training include:

- explanations of the requirements of the standard
- identification of workplace operations where hazardous chemicals are present
- knowledge of the methods and observations used to detect the presence of hazardous workplace chemicals
- assessment of the physical and health hazards of those chemicals

- warnings about hazards associated with chemicals in unlabelled pipes
- descriptions of hazards associated with non-routine tasks
- details about the measures employees can take to protect themselves against these hazards, including specific procedures
- explanation of the labeling system
- instructions on location and use of material safety data sheets (MSDSs)
- details on the availability and location of the hazardous materials inventory, MSDSs, and other written hazard communication material

Hazard Warning Symbols

Chemicals produced in the USA come under OSHA Hazard Communication Standard. The label on the container must warn about potential hazards of the product. OSHA does not require hazard symbols on the label, however, the skull and crossbones symbol is acceptable on containers of highly toxic substances, and the flame symbol is acceptable on containers of flammable substances.

Section VII

Information Sources

1. Canadian Government Departments with Responsibility for Occupational Health and Safety
2. US Federal Safety and Health Agencies

1. Canadian Government Departments Responsible for Occupational Health and Safety

While all jurisdictions have legislation pertaining to the safety of the workplace, there is relatively little or no legislation in Canada that mentions specific reference to maintaining general employee wellness. You should contact your jurisdiction directly for more information.

Canadian Centre for Occupational Health and Safety (CCOHS)

Client Services
Phone: 905-570-8094
Toll-free: 1-800-668-4284 (Canada and US only)
Fax: 905-572-2206
E-mail: clientservices@ccohs.ca
Web Site: www.ccohs.ca

Inquiries Service
(FREE answers to your OH&S questions)
Phone: 905-572-4400
Toll-free: 1-800-263-8466 (Canada only)
Fax: 905-572-4500
E-mail: inquiries@ccohs.ca
OSH Answers Web Site: www.ccohs.ca/oshanswers

Federal Jurisdiction

Occupational Health and Safety
Labour Program
Human Resources Development Canada
Ottawa ON K1A 0J2

Regional and District Offices
info.load-otea.hrdc-drhc.gc.ca/~oshweb/contacten.shtml

Provincial Jurisdictions

Alberta

Workplace Health and Safety
Alberta Human Resources and Employment
9940-106 Street
Edmonton, AB T5K 2N2
General Inquiries: (780) 427-8848
Fax: (780) 427-0999
Calgary: (403) 297-2222
Fax: (403) 297-7893
Web Site: www.gov.ab.ca/hre/whs/

British Columbia

Workers' Compensation Board of British Columbia
6951 Westminster Highway
PO Box 5350 Stn Terminal
Richmond, BC V6B 5L5
General Inquiries: (604) 273-2266
Fax: (604) 276-3247

Health & Safety Questions
Phone: (604) 276-3100
Toll-free in B.C.: 1-888-621-7233 (SAFE)

After Hours Safety and Health Emergency Reporting
Phone: (604) 273-7711
Toll-free in B.C.: 1-888-621-7233 (SAFE)
Web Site: www.worksafebc.com

Manitoba

Workplace Safety and Health Division
Manitoba Labour
200-401 York Avenue
Winnipeg, MB R3C 0P8
General Inquiries: (204) 945-3446
Toll free in Manitoba: 1-800-282-8069
After hours: (204) 945-0581
Fax: (204) 945-4556
Web Site: www.gov.mb.ca/labour/safety/

New Brunswick

Workplace Health, Safety and Compensation Commission of New Brunswick

500 Beaverbrook Court
Fredericton, NB E3B 5X4
General Inquiries: (506) 453-2467
Toll-free in NB: 1-800-442-9776
Fax: (506) 453-7982
Web Site: www.whscc.nb.ca/

Newfoundland and Labrador

Department of Labour

Confederation Building, 4th Floor, West Block
PO Box 8700
St. John's, NF A1B 4J6
General Inquiries: (709) 729-7420
Toll-free in NF: 1-800-563-5471
Fax: (709) 729-3445
Web Site: www.gov.nf.ca/labour/

Northwest Territories and Nunavut

Workers' Compensation Board of Northwest Territories and Nunavut

PO Box 8888
Yellowknife, NT X1A 2R3
General Inquiries: (867) 920-3888
Toll free: 1-800-661-0792
Fax: (867) 873-4596
Web Site: http://www.wcb.nt.ca/home.htm

Nova Scotia

Nova Scotia Department of Environment and Labour
Occupational Health and Safety Division
5151 Terminal Rd., 6th Floor
PO Box 697
Halifax, NS B3J 2T8
General Inquiries: (902) 424-5400
Toll free in NS: 1-800-952-2687
Fax: (902) 424-3239
Web Site: http://www.gov.ns.ca/enla/ohs/

Ontario

Ministry of Labour
Occupational Health and Safety Branch
400 University Avenue, 7th Floor
Toronto, ON M7A 1T7
General Inquiries: (416) 326-7770
Toll free in Ontario: 1-800-268-8013
Fax: (416) 326-7761
Web Site: www.gov.on.ca/lab/ohs

Prince Edward Island

Workers' Compensation Board of PEI
Occupational Health and Safety Division
PO Box 757, 14 Weymouth Street
Charlottetown, PE C1A 7L7
General Inquiries: (902) 368-5680
Toll-free in PEI: 1-800-237-5049
Fax: (902) 368-5705
Web Site: www.wcb.pe.ca

Québec

Commission de la santé et de la sécurité du travail du Québec (CSST) (Occupational Health & Safety Commission)

CP 6056, Succursale Centre-ville
Montréal, PQ H3C 4E1
Phone: (514) 906-3060
Toll-free in PQ: 1-800-667-7585
Fax: (514) 906-3062
Web Site: www.csst.qc.ca

Saskatchewan

Saskatchewan Labour
Occupational Health and Safety Division

1870 Albert Street
Regina, SK S4P 3V7
General Inquiries: (306) 787-4496
Toll-free in SK: 1-800-567-7233
Fax: (306) 787-2208
Web Site: www.labour.gov.sk.ca/

Saskatoon Office:
Phone: (306) 933-5042
Toll-free: 1-800-667-5023
Fax: (306) 933-7339

Yukon Territory

Yukon Workers' Compensation, Health and Safety Board, Occupational Health and Safety Branch

401 Strickland Street
Whitehorse, YT Y1A 5N8
General Inquiries: (867) 667-5645
Toll free in the Yukon: 1-800-661-0443
Fax: (867) 393-6279
Web Site: http://www.wcb.yk.ca

For an up-to-date listing of information sources visit *http://www.ccohs.ca/oshanswers/information/govt.html*

2. US Federal Safety and Health Agencies

US Environmental Protection Agency (EPA)

Ariel Rios Building
1200 Pennsylvania Avenue N.W.
Washington, DC 20460
Phone: (703) 412-9810
Toll-free: 1-800-424-9346
Web Site: www.epa.gov

National Institute for Occupational Safety and Health (NIOSH)

4676 Columbia Parkway
Cincinnati, OH 45226
Publications Dissemination
Phone: (513) 533-8328
Fax: (573) 533-8573
Toll-free in the US: 1-800-35-NIOSH
(1-800-356-4674)
Outside the US: (513) 533-8471
E-mail: PubstaFt@cdc.gov
Web Site: www.cdc.gov/NIOSH/homepage.html

Occupational Safety & Health Administration (OSHA)

200 Constitution Ave., NW
Washington, DC 20210
Phone: (202) 693-1999
Toll free: 1-800-321-OSHA
Web Site: www.osha.gov

A listing of the Regional Offices follows:

OSHA Regional Offices

Region 1: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont, US Dept. of Labor—OSHA

JFK Federal Building, Room E340
Boston, MA 02203
Phone: (617) 565-9860
Fax: (617) 565-9827
Web Site: www.osha.gov/oshdir/r01.html

Region 2: New Jersey, New York, and Puerto Rico, Virgin Islands, USA Dept. of Labor—OSHA

201 Varick St., Rm. 670
New York, NY 10014
Phone: (212) 337-2378
Fax: (212) 337-2371
Web Site: www.osha.gov/oshdir/r02.html

Region 3: District of Columbia, Delaware, Maryland, Pennsylvania, Virginia and West Virginia, USA Dept. of Labor—OSHA

The Curtis Center-Suite 740 West
170 S. Independence Mall West
Philadelphia, PA 19106-3309
Phone: (215) 861-4900
Fax: (215) 861-4904
Web Site: www.osha.gov/oshdir/r03.html

Region 4: Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee, USA Dept. of Labor—OSHA

61 Forsyth St. SW
Atlanta, Georgia 30303
Phone: (404) 562-2300
Fax: (404) 562-2295
Web Site: www.osha.vog/oshdir/r04.html

Region 5: Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin, USA Dept. of Labor—OSHA

230 South Dearborn St., Rm. 3244
Chicago, IL 60604
Phone: (312) 353-2220
Fax: (312) 353-7774
Web Site: www.osha.gov/oshdir/r05.html

Region 6: Arkansas, Louisiana, New Mexico, Oklahoma, and Texas, USA Dept. of Labor—OSHA

525 Griffin St., Rm. 602
Dallas, TX 75202
Phone: (214) 767-4731
Fax: (214) 767-4137
Web Site: www.osha.gov/oshdir/r06.html

Region 7: Iowa, Kansas, Missouri, and Nebraska, USA Dept. of Labor—OSHA

City Center Square
1100 Main St., Suite 800
Kansas City, MO 64105
Phone: (816) 426-5861
Fax: (816) 426-2750
Web Site: www.osha.gov/oshdir/r07.html

Region 8: Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming, USA Dept. of Labor—OSHA

1999 Broadway, Suite 1690
Denver, CO 80202-5716
Phone: (303) 844-1600
Fax: (303) 844-1616
Web Site: www.osha.gov/oshdir/r08.html

Region 9: Samoa, Arizona, California, Guam, Hawaii, Nevada, and Trust Territory of the Pacific Islands, USA Dept. of Labor—OSHA

71 Stevenson Street St.
4th Floor, Suite 420
San Francisco, CA 94105
Phone: (415) 975-4310
Fax: (415) 975-4319
Web Site: www.osha.gov/oshdir/r09.html

Region 10: Alaska, Idaho, Oregon, Washington, USA Dept. of Labor—OSHA

1111 Third Avenue, Suite 71
Seattle, Washington 98101-3212
Phone: (206) 553-5930
Fax: (206) 553-6499
Web Site: www.osha.gov/oshdir/r10.html

State Occupational Safety and Health Plans

Alaska

Alaska Department of Labor
P.O. Box 21149
Juneau, Alaska 99801-1149
Physical location
1111 W. 8th Street, Room 304
Juneau, Alaska 99801-1149
Internet: http://www.labor.state.ak.us/lss/lss.htm

Arizona

Industrial Commission of Arizona
800 W. Washington
Phoenix, Arizona 85007-2922
Telephone: (602) 542-4411
(602) 542-5795
Fax: (602) 542-1614
Internet: http://www.ica.state.az.us/ADOSH/oshatop.htm

California

California Department of Industrial Relations
455 Golden Gate Avenue - 10th Floor
San Francisco, California 94102
Telephone: (415) 703-5050
Fax: (415) 703-5114
Internet: http://www.dir.ca.gov/occupational_safety.html

Connecticut

Connecticut Department of Labor
Consultation Services
Division of Occupational Safety and Health
38 Wolcott Hill Road
Wethersfield, Connecticut 06109
Telephone: (860) 566-4550
Fax: (860) 566-6916
Internet: http://www.ctdol.state.ct.us/

Hawaii

Hawaii Department of Labor and Industrial Relations
Consultation and Training Branch
830 Punchbowl Street
Honolulu, Hawaii 96813
Telephone: (808) 586-9100
Fax: (808) 586-9104
Internet: http://www.state.hi.us/dlir/hiosh/

Indiana

Indiana Department of Labor
Bureau of Safety, Education and Training
Division of Labor, Room W195
402 West Washington
Indianapolis, Indiana 46204-2287
Telephone: (317) 232-2688
Fax: (317) 232-3790
Internet: http://www.state.in.us/labor/iosha/iosha.html

Iowa

Iowa Division of Labor Services
Consultation Program
1000 E. Grand Avenue
Des Moines, Iowa 50319-0209
Telephone:(515) 281-7629 Consultation
Telephone:(515) 281-0202 Education
Fax: (515) 281-5522
Internet: http://www.state.ia.us/iwd/labor/index.html

Kentucky

Kentucky Labor Cabinet
1047 U.S. Highway 127 South, Suite 4
Frankfort, Kentucky 40601

OSH Division of Compliance
Telephone: (502) 564-3070 ext. 305
Fax: (502) 564-4769

OSH Division of Education and Training
Telephone: (502) 564-3070 ext. 266
Fax: (502) 564-4769 FAX
Internet: http://www.state.ky.us/agencies/labor/kyosh.htm

Maryland

Maryland Department of Labor, Licensing and Regulation

1100 North Eutaw Street, Room 613
Baltimore, Maryland 21201-2206
Maryland Occupational Safety & Health (MOSH)
Telephone: (410) 767-2215
Fax: (410) 333-7747
Internet: http://www.dllr.state.md.us/labor/mosh.html

Michigan

Michigan Department of Consumer and Industry Services, Bureau of Safety and Regulation

7150 Harris Drive
P.O. Box 30643
Lansing, Michigan 48909-8143
Telephone: (517) 322-1814
Fax: (517) 322-1775
Internet: http://www.cis.state.mi.us/bsr/

Minnesota

Minnesota Department of Labor and Industry

443 Lafayette Road North
St. Paul, Minnesota 55155-4307
Telephone: (651) 284-5050
Fax: (651) 282-5405
Internet: http://www.doli.state.mn.us/wsc.html

Nevada

Nevada Division of Industrial Relations

Occupational Safety and Health Enforcement Section (OSHES)
1301 N. Green Valley Parkway – Suite 200
Henderson, Nevada 89014-6197

Las Vegas

Telephone: (702) 486-9168
Fax: (702) 990-0358

Carson City

Telephone: (775) 687-5240
Fax: (775) 687-6150
Internet: http://www.state.nv.us/

New Jersey

New Jersey Department of Labor
Division of Public Safety and Occupational Safety and Health
225 E. State Street
8th Floor West
P.O. Box 953
Trenton, New Jersey 08625-0953
Telephone: (609) 292-3923
Fax: (609) 292-4409

Consultation Web Page:
http://www.state.nj.us/labor/wps/psosh/onsite/onsite.htm

New Jersey State OSH Plan Web Page:
http://www.state.nj.us/labor/wps/psosh/peosh.htm

New Mexico

New Mexico Environment Department
Occupational Health and Safety Bureau
525 Camino de Los Marquez, Suite 3
PO Box 26110
Santa Fe, New Mexico 87502
Telephone: (505) 827-4230
Fax: (505) 827-4422
Internet: http://www.nmenv.state.nm.us/

New York

New York Department of Labor
W. Averell Harriman State Office Building–12
Room 500
Albany, New York 12240
New York On-Site Consultation Program
State Office Campus Building 12, Room 168
Albany, New York 12240
Telephone: (518) 457-2238
Fax: (518) 457-3454
Internet: http://www.labor.state.ny.us/working_ny/worker_rights/safety_health.html/

North Carolina

North Carolina Department of Labor (NCDOL)
4 West Edenton Street
Raleigh, North Carolina 27601-1092
Bureau of Consultative Services
Telephone: (919) 807-2899
Fax: (919) 807-2902
Internet: http://www.dol.state.nc.us/osha/osh.htm

Oregon

Oregon Occupational Safety and Health Division
Department of Consumer & Business Services
350 Winter Street, NE, Room 430
Salem, Oregon 97310
Telephone: (503) 378-3272
Toll-free in Oregon: (800) 922-2689
Internet: http://www.orosha.org/

Puerto Rico

Puerto Rico Department of Labor and Human Resources
Occupational Safety and Health Office
Department of Labor and Human Resources, 20th Floor
505 Muñoz Rivera Avenue
Hato Rey, Puerto Rico 00918
Telephone: (787) 756-1100, 1106
Fax: (787) 767-6051
Internet: http://dtrh.prstar.net/osho%20english.htm

South Carolina

South Carolina Department of Labor, Licensing and Regulations
Office of OSHA Compliance
3600 Forest Drive
PO Box 11329
Columbia, South Carolina 29204
Telephone: (803) 734-9644
Fax: (803) 734-9772
Internet: http://www.llr.state.sc.us/osha.asp

Tennesse

Tennessee Department of Labor and Workforce Development
OSHA Consultative Services
Tennessee Department of Labor and Workforce Development
710 James Robertson Parkway, 3rd Floor
Nashville, Tennessee 37243-0659
Telephone: (615) 741-7036
Fax: (615) 532-2997
Internet: http://www.state.tn.us/labor-wfd

Utah

Utah Labor Commission
Consultation Services
160 East 300 South, 3rd Floor
Salt Lake City, Utah 84114-6650
Telephone: (801) 530-6901
Fax: (801) 530-6992
Internet: http://www.labor.state.ut.us/ Utah_Occupational_Safety___Hea/utah_occupational_safety___hea.html?

Vermont

Vermont Department of Labor and Industry
Division of Occupational Safety & Health
National Life Building, Drawer 20
National Life Drive
Montpelier, Vermont 05602-3401
Telephone: (802) 828-2765
Fax : (802) 828-2748
Internet : http://www.state.vt.us/labind/vosha.htm

Virginia

Virginia Department of Labor and Industry
Powers-Taylor Building
13 South 13th Street
Richmond, Virginia 23219
Telephone: (804) 786-2377
Fax: (804) 371-6524
Internet: http://doli.state.va.us/

Virgin Islands

Virgin Islands Department of Labor
Division of Occupational Safety and Health
3021 Golden Rock
Christiansted, St. Croix, Virgin Island 00840
Telephone: (340) 772-1315
Fax: (340) 772-4323

Washington

Washington Department of Labor and Industries
PO Box 44001
Olympia, Washington 98504-4001
Telephone : (360) 902-4200
Fax: (360) 902-4202
Internet: http://www.lni.wa.gov/wisha/

Wyoming

Wyoming Department of Employment
Workers' Safety and Compensation Division
Herschler Building, 2nd Floor East
122 West 25th Street
Cheyenne, Wyoming 82002
Telephone: (307) 777-7786
Fax: (307) 777-5850
Internet: http://wydoe.state.wy.us/doe.asp?ID=7

Appendices

A1. Conversion Tables

A2. Abbreviations

A1. Conversion Tables

Length

English		Metric
39.37 inches	=	1.0 meter
1.0 meter	=	3.28 feet
1.0 foot	=	30.48 centimeters

Mass and Weight

English		Metric
1.0 pound	=	0.454 kilograms
1.0 ounce	=	28.3 grams
2.2 pounds	=	1.0 kilogram
0.035 ounce	=	1.0 gram

Volume (Gases)

English		Metric
1.0 cubic foot (ft^3)	=	0.0283 cubic meter (m^3)
35.3 cubic foot (ft^3)	=	1.0 cubic meter (m^3)
1 cfm	=	0.000472 m^3/s
	=	0.472 litres per second (L/s)
cfm	=	cubic foot per minute
m^3/s	=	cubic meter per second
L/s	=	litre per second

Pressure

English		
1 psi (pound force per square inch)	=	6.8948 kPa (kilopascals)
Atmospheric pressure	=	101.325 kPa

A2. Abbreviations

ACGIH: American Conference of Governmental Industrial Hygienists. ACGIH is a professional society of government workers and educators who work to promote occupational safety and health. The organization publishes recommendations on ventilation, air sampling and airborne chemical concentration guideline (threshold limit values or TLVS) designed to limit and control exposure of workers to airborne chemicals in the workplace.

ANSI: American National Standards Institute; an American organization that produces the ANSI standards.

ASHRAE: American Society of Heating, Refrigeration and Air Conditioning Engineers – sets ventilation and other standards related to the indoor environment.

AWS: American Welding Society – an excellent resource for publications and standards on welding related topics.

CCOHS: Canadian Centre for Occupational Health and Safety, Canada's national organization for promotion of workplace health and safety by providing information, advice, training and research.

CGSB: Canadian General Standards Board.

CSA: Canadian National Standards Association, a national organization that produces CSA standards.

EPA: U.S. Environmental Protection Agency.

FCAW: Flux-Cored Arc Welding

GMAW: Gas Metal Arc Welding

GTAW: Gas Tungsten Arc Welding

IAPA: Industrial Accident Prevention Association, Ontario

IARC:	International Agency for Research on Cancer. IARC, part of the World Health Organization, is an international organization that evaluates the human cancer risk from chemical exposure.
ISO:	International Organization for Standardization, an international organization that produces the ISO standards.
MSDS:	Material Safety Data Sheet - provides information about toxicity and safe work practices for chemicals
NFPA:	National Fire Protection Association (USA). Publishes the Fire Code.
NIOSH:	U.S. National Institute for Occupational Safety and Health. NIOSH, part of the Center for Disease Control, conducts research on worker safety and health and recommends standards for worker protection to OSHA.
OSHA:	U.S. Occupational Safety and Health Administration, develops and enforces health and safety legislation
PAW:	Plasma Arc Welding
PAC:	Plasma Arc Cuttings
PPE:	Personal protective equipment: hard hat, ear plugs, safety boots, gloves, etc
SAW:	Submerged Arc Welding
SMAW:	Shielded Metal Arc Welding
TLV:	Threshold Limit Values recommended by ACGIH – often used as guidelines to set occupational exposure limits
UV:	Ultraviolet radiation - invisible radiation emission from the welding arcs
WCB:	Workers' Compensation Board
WSIB:	Workplace Safety and Insurance Board (Ontario)

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